ANTHROPOMETRY

AND

PHYSICAL EXAMINATION

A BOOK

FOR PRACTICAL USE IN CONNECTION WITH GYMNASTIC WORK AND PHYSICAL EDUCATION.

BY

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PREFACE.

The only reason for the appearance of this little book is the desire to meet to some extent the demand that exists for instruction in the great field of physical education, and thus to put a work of the greatest importance on a higher plane. The organization of schools in this country, for the training of teachers to take charge of the physical education of the people, is a recent development. The demand for competent instructors in this department of work has far outstripped the supply and therefore whatever will prove a help to instruction is to be welcomed, however meagre and unpretentious it may be.

The only excuse that can be urged for the imperfect and poorly-arranged character of the work is that it has been done in moments between professional cares and college duties.

I wish to express my thanks to Drs. Hitchcock of Amherst, Kellogg, Hitchcock of Cornell, Anderson, Sargent, Savage, and others, for the courtesy they have shown me in permitting the use of material that has been prepared by them at great expense of time and labor.

JAY W. SEAVER.

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CHAPTER I.

THE USES OF ANTHROPOMETRY AND THE EXAMINER HIMSELF.

Educational systems are rapidly being broadened by the new standards that have been set by the advance of science or the demands of social organization. At one stage in the history of civilization the great man was the one who overpowered all others by physical strength. Such a man easily gathered around him a retinue of weaker followers, either as subdued competitors or weak dependants who must seek some strong person for protection. This condition of affairs evolved great physical hardihood and endurance but the limitations of development were reached under ignorance of physiological laws and the waste caused by imprudence. Later on the mental activity of the genius gave him a new weapon in competition, and a new force was added to the growth of civilization. This new element was in one respect at least entirely different from the old dominating force, in that it could be shared with others without loss to the original possessor. Any new invention or craft or idea could be taught to others while mere physical strength could only be directly transmitted through hereditary channels.

It is safe to say that for the last three-quarters of a century the history of civilization must record rapid physical deterioration among the families who have been most active in evolving new ideas for the refinement of life and the amelioration of its hardships. Close application in each department of mental activity and a consequent neglect of the physical basis for life, which depends on muscular activity, have drawn heavily on the surplus vitality stored up by many generations of healthy and frugal ancestors; and

in too many cases we find prominent names drop altogether from town records and public lists. France has already reached a point in her history as a people when the natural physical increment barely meets the yearly loss of her population, and similar tendencies everywhere are calling the attention of thinking people to the startling limitations that stare civilization in the face.

Medical science has, by the discovery and promulgation of physiological laws and hygienic principles, done much to avert the disaster by eliminating many of the deleterious influences that act with special potency against the weakened and delicate. The beneficent influence on humanity has been partly overcome, however, by the rearing of weaklings whose career would have been short under less intelligent care; but, neglecting this part of the race that is doomed to natural extinction, we find that medical science has done nothing directly to avert the calamity that has menaced civilization from extreme specialization.

It is but natural that the evil effects of excessive mental stimulation without a suitable physical basis for the support and expression of nervous phenomena should have first been noticed by educators and those with training in some scientific pursuit. Ling of Sweden gave his life to the study of the needs of the body, and established a system of exercises that would do for the *body* what the routine of study would do for the *mind*. His exercises were graded from light, free movements up to complicated work with apparatus, thus forming a complete system of physical education that has been prescribed by law in all the schools of Sweden. What Ling did for Sweden Jahn did for Germany, establishing a system of societies where the practice of bodily exercises was the principal feature of the oranization, the improvement in physical stamina and the patriotic zeal that resulted was sufficient to drive Napoleon out in 1810, and since that date there have been efforts to make physical training universal in the German Empire, and with satisfactory results.

In France the establishment of the Republic was the time when public attention was first aroused to the needs of a physical education that should proceed hand in hand with the school work of the children; but factional dissension and the reorganization of a government have taken so much of the interest of the people that French educational matters have not kept pace with the progress in other countries.

In England there has been no great demand for physical training, for the active outdoor sports that engage old and young have taken the place of the rural occupations and hunting that the early Kelt and Saxon followed—except in the larger cities, and there competent observers like Francis Galton, and Dr. Roth and Mrs. Westlake, of the London School Board, insist that some form of physical education must be adopted.

In America the development of a matchless territory by a population that is heterogeneous, representing all conditions of life placed on a common plane, has given free scope to competition. The large return for labor has incited to the fullest expenditure of effort. Wealth has grown enormously. The unnatural distribution of industries, caused by legislative interference with supply, has caused an unnatural and unfortunate location of the people. Twenty years have seen our urban population more than double, while in the older parts of the country the rural population barely holds its own. The rapid development of complicated systems of business in the scramble for sudden wealth has required the outlay of intense energy, and this demand on the vital force of the people has come before they were fully acclimated to the new conditions of the country. The result has been an excess of nervous diseases and premature breaking down of our people. The time when a large majority of our people worked out in the open air has passed, and now the counting-room and the factory shut in the majority during the hours of sunlight. This strain on vitality is beginning to be felt, and a remedy must be sought at once in all the large cities of

the country. In some way, artificial though it be, some increase of vitality must be found. The sturdy strength of our fathers, that was gained by an active life in the open air, cutting forests, cultivating land, traveling on horseback, in the service of society, sailing ships, and kindred pursuits, must now be gained by exercise obtained in another way.

In response to this feeling of a need of improving the physical side of our lives there has been a widespread movement in the cities of our country toward the formation of clubs for exercise. In the larger cities these clubs have provided large and well equipped gymnasiums for the use of members, and in the smaller towns the Young Men's Christian Associations have been the pioneers in this work of improving the physical status of the young. But in each town where a gymnasium was provided by some organization there has been an appreciation of imperfect, if not of disastrous, results from the lack of intelligent direction and competent instruction.

A gymnasium has been compared, by some writer, to a drug store—full of good things if intelligently used, but full of evils if taken indiscriminately. The number of men who were fitted to take charge of a gymnasium even ten years ago was exceedingly limited, and these few were mostly Germans who understood German methods and German needs better than they did American.

The question, then, has been and is, What use of the gymnasium will be best for the individual case? Does he need a large or small dose?

The physician in treating his patient must recognize every sign and symptom, and then, with whatever historical data he can discover to aid his judgment, he prescribes treatment. It must be so in our management of cases in the gymnasium. We must learn what is the physical peculiarity and condition of each pupil. A general system of light exercises can be carried out successfully if the instructor is conservative and careful, without a physical examin-

ation as the first step ; but, to do the best with the facilities, there must be intelligent discrimination of work, as so few persons have the same physical requirements even if healthy. The director, then, must know what material he would mould and develop, and he must again examine to see if the results of his treatment are satisfactory or such as he expected, and hence the need of a record of the past condition. A statement of a size or strength in black figures is worth a dozen "opinions." For the imperfect the examination will cause a cautionary signal to "go slowly" or "stop" to be hung out before disaster comes and discredit is thrown on the work, or a new method is prescribed that affords relief.

Science has taught us that in living organisms functional activity must be kept up, or there will be no development. A part or group of organs unused will atrophy and become useless. Heredity soon stamps a deformity, that has been developed in two or three generations, as a type and succeeding generations that do not possess that peculiarity are looked upon almost as new varieties. This is especially true of physical defects that impair the vitality of the parents. Notice the stress laid upon this law by life insurance companies where business interests have no bias from sentiment. The excellent health of the applicant is not enough, if there be a record going back two or three generations of degenerative diseases that have proved fatal, or if the constitutional vigor has been so weak as to let the life go out at about forty-five or fifty years of age from any immediate cause.

The first lesson that we must learn from this truth is, that health can not exist if vital organs are seriously undeveloped.

Health is the condition of harmonious adjustment of *all* the functional activities. For instance ; a normal pulse rate is from 72 to 76 beats per minute, under ordinary conditions of rest, but a pulse-rate of 72 after a half-mile run might be considered abnormal and the ground for solici-

tude,—for health would demand an increased activity of the heart muscle to supply increased blood currents to the active muscles, that waste products may be eliminated and restorative elements supplied. But further: An adjustment of the pulse rate is not all that is to be required in the case cited; for there must be a corresponding increase of respiration for elimination and oxidation. And so the perfect activity of any organ—even the brain—may be shown to be dependent on the healthy activity of other organs, while the converse may be stated as a physiological truth, viz: that the imperfect action of any organ impairs the function of all others to some extent. A healthy muscle is, then, dependent on a healthy stomach, heart and brain no less than on good food, air, etc., while the more refined intellectual processes are also based on a normal condition of the physical organs. A person may accomplish much and be a dyspeptic, and so, too, may a cripple walk a long distance on crutches. A healthy child, then, is better fitted for study than a puny one, and health should be the first thing sought in our schools that are educating children for the duties of life. For the education of the body we may with profit pursue the same pedagogic system that gives good results in mental training. The teacher must know something of the existing powers and acquisitions of the pupil, in order to give proper instruction. In schools the daily recitation is an examination into the results of study and previous instruction, and the mind of the pupil is directed into new channels of thought.

The inductive method of progress (from the simple to the complex), should be followed in the physical as well as the mental training of youth. The body, like the mind, should be taught the simple principles of exercise, and then the complex and intricate movements become easy of mastery. Then there will be perfect grace of motion, because there will be perfect control of every muscle and also mental assurance or self-confidence.

To illustrate the command of the body that results from

systematic physical training, from simple up to complex motions, varying for each hand: I have recently been told by a physician—an accomplished gymnast—that after practising on complex movements with the hands and fingers for some weeks he thought he would try to discover whether or not it had given him any new control of the parts for entirely new work. He had a fair theoretical knowledge of music, and played the piano, but had never attempted to play on a stringed instrument. He procured a violoncello and a book of instruction that showed him the theory of the keyboard, the strings, etc. He began practice in his spare time and in *two weeks* could play with such ability as to receive and accept a position to play in public with an orchestra each week.

I have repeatedly seen boys, so clumsy and awkward that they could not keep step with a squad, while marching the length of the gymnasium—boys so self-conscious and so lacking in self-control that social life was a burden to them—become fairly graceful and easy in movement and carriage after a few months' work in the development of neglected muscles and the quickening of reflex action by nerve exercise and well-balanced activity.

A clumsy person is, in a certain sense, a sufferer from partial paralysis. There are undeveloped nerve centers or nerve fibres, that, if not quickened into life, will continue to degenerate and in their decay will involve, or, at least, affect other centers. The process may be slow, for the reflex influence of active parts may arrest the degeneration to some extent ; but it is not a healthy organism able to resist the encroachments of disease or the strain of prolonged work and excitement.

So practical a business man as the Hon. Thomas G. Shearman says : "I do not underrate the value of pure mental training, especially as that is nearly all which I have myself received ; but my very lack of training in physical labor has led me to observe the great value which it has not merely with reference to bodily health and

strength but for the very purpose of enlarging the *mental faculties.*" *

The acquisition of new powers over reflex or complicated movements is much more rapid in early life than after maturity. The old saying that "It is hard to teach old dogs new tricks" had its origin in this tendency to persistency in any habit of body or mind. A system of education that has in view the symmetrical relations of mental and physical qualities, can not ignore the necessity of beginning physical training with the mental. The child should come under the care of an experienced instructor in physical training from the day of entrance to regular school life. A physical examination should be made that should determine the condition of heart, lungs, spine, muscles, skin, eyes and ears. Many a case of incipient disease that eventuates in disaster, would be discovered, and put in the care of a physician, if necessary, or a correct regime of diet, sleep, exercise, etc., inaugurated with the aid of the parents, that would counteract the tendency to disease or deformity and save the child as a useful member of society.

Many parents have no idea that there is serious deformity that menaces health in their children, until a stranger points it out to them. The worst case of varicose veins that I ever saw in a young person was found in making examinations for a large school, when a son of a physician came under my eye. The case was referred to parental care and advice, and what was my surprise to learn that the father was entirely ignorant of his son's condition! It may not be the province of the State to see that each child has medical care; but, so long as the State takes a child from home for five hours out of the day, it is bound to see that no physical harm comes to the child in that time; and, if education is for public policy or utility, the care that will produce the best citizen is the care that is demanded.

At the time of this examination a few measurements

* Rept. of 3rd annual meeting of Amer. Econ. Assoc., Philad., 1889.

should be made and recorded for the direct advantage of instructor and child and the aid that all such material will give to science. The age, weight, height, height sitting; girth of head, neck, chest, depressed and inflated, waist and hips, breadth of shoulders, chest, waist and hips, are all important items. There will be only a very small per cent. of children in the primary grades that can not take the general exercises that will be prescribed, but in higher grades the number will increase, and among advanced students may reach as high as five per cent. Now an advantage of keeping a record of measurements will be, that the actual growth under a given system of exercise can be seen and, if the progress is not satisfactory, the cause may be sought or a new system adopted for these cases. The experienced examiner will be aided in forming an opinion of the needs of a case by seeing the actual measurements and comparing them with an average or standard, while the beginner will rely on them entirely until he gets an ideal or standard of excellence fixed in his own mind. The child will invariably take more interest in exercises if he knows what the exercise is for and can see that he needs it; or will feel increased pride in keeping ahead of the standard, if he once has passed it.

After the age of puberty the measurements should be more numerous, and should include tests for strength of various parts. This will show any minor defects in time to modify them during the period of growth; for after this age the boy or girl will have judgment and interest enough to carry out any regulations that shall have in view the strength or beauty of their bodies, and a set of measures, or a graphic chart, or both, that will show them where their small records are, will greatly reënforce the directions that may be given them regarding exercise. Again it will help to eradicate from their minds a false standard of beauty and symmetry and give them an intelligent basis of judgment of their own shape. It also enables them to see the actual progress that is made under certain

exercises and determines the point of physical maturity when further growth stops.

It will serve as a check to over-development of any part which may be quite as injurious to the health as undevelopment; in short, there is no other intelligent and systematic way of undertaking physical training than by finding out first, what is needed, and second, prescribing exercise that shall build up the weak parts.

The following simple table has been devised and used by Dr. Anderson. Department of Physical Education of the Adelphi Academy, Brooklyn, N. Y.

PHYSICAL CONDITION OF.....

GRADE.....

DATE.	Age.	Height.	Weight	Lung Capacity.	What it should be.					
AGE.....	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**	**14.**	**15.**	
Height ..	46.40	48.90	50.17	52.26	54.43	56.86	57.79	59.92	62.53	64.38	Boys.
Weight ..	47.55	56.44	58.09	63.86	71.42	76.17	81.81	95.20	105.15	113.81	
Lung Capacity.	64	80	88	106	124	144	150	168	188	205	
Height ..	46.11	47.95	49.82	52.03	53.99	57.06	59.17	60.89	63.38	63.12	Girls.
Weight ..	46.55	50.83	56.37	62.32	71.52	80.81	90.68	99.61	108 99	112.80	
Lung Capacity	35	40	48	65	80	106	125	136	150	155	

[The above figures show the average height, weight, and about the lung capacity of the pupils in a number of the private schools in and near Brooklyn. They are given only for comparison. It cannot be said of them that they indicate just what the averages should be.]

Parents are earnestly requested to notify the Physician in charge of this department, of Physical Defects, if any, that exist in their children, that he may regulate the exercises accordingly.

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Director Physical Education.

And now a word in regard to the examiner himself: It is obvious that a medical training is of very great advantage to the person who is to make such physical diagnosis and measurement as shall be strictly scientific and accurate; but with the thorough knowledge of anatomy and physiology that can be gained in the Normal Schools of Physical Education, and a little practice under the supervision of a physician who can demonstrate abnormal heart and lung sounds, and a great deal of practice on normal sounds, the beginner need not be lacking in confidence or accuracy of work, as he must never be lacking in care. If the examiner has not a medical education, let him always err on the safe side in a doubtful case and require a certificate from a physician before entering on a course of advanced exercise, or athletic work. But first let him study the case, using all the light that can be thrown on it from books and the history that can be obtained. The examiner must be a student, he must learn, he must study, examining not only the client but books, papers, periodicals. Anything bearing on his subject should be studied and questioned, but not criticised until he is sure of some error; then let him correct the error by showing its inaccuracy of fact or logic.

Do not take the statement of anybody as infallible. If it clashes with your own idea examine it and decide who is wrong.

Do not run after everything new and think that the new apparatus will make exercise a pleasure and relieve you of your work, or the new idea will save you the trouble of thinking.

Do not go through your work in a perfunctory sort of a way, but be enthusiastic and full of interest in those with whom you come into the relationship of advisor and instructor.

Be earnest, careful and exact, filled with the spirit of hard work, or move on to some less onerous occupation.

Do not try to find some fault with each person who comes under your care, nor continually decry habits that you believe to be bad. If you believe, as I do, that the use of tobacco is injurious to the majority of smokers, do not tell every person, whose breath "gives him away," that he is "killing himself" by smoking, or that he has the "smoker's heart" and must reform at once if he wishes to rob the grave of an early victim; for in every such case you will be either informed that the smoker has no desire to go into the business of robbing graves or you will be set down as a bigot whose opinion is good for nothing, and whose advice is worth still less. If a person asks you if you think tobacco has hurt him, and you find no indication of injury, be honest enough to tell him so, and your candor will so establish his confidence in you that the subsequently expressed opinion, that tobacco has done him no good, will be likely to set him to thinking. At times you are expected to express yourself freely, as when lecturing on any subject, but do not try to pour a lecture into the unwilling ears of everyone who may chance to fall into your hands. You do no good but make yourself ridiculous.

Establish a record for honesty and ability, and your advice will be sought. Integrity is the largest factor in influence.

Endeavor to find out the actual condition of each organ and do not be too quick to decide on the cause of any abnormality. If the heart action is imperfect and the person uses tobacco remember that there are occasionally "bad" hearts in those who have never "used the weed." A lateral curvature of the spine also may be due to no muscular inefficiency or weakness but may indicate good muscular action, as in case of a shorter leg on one side.

Do not be boastful and proudly claim to have discovered a new "system" or a "natural" system of exercise because you have by a certain method of life acquired a large biceps or general good physique. Your size of arm

may have as little relation to any *system* as your size of hat. Because Dr. Tanner lived forty days without food he did not establish a system of living without food; and because some "Prof." can live comfortably by breathing only three times a minute it does not follow that he has a "system" all his own; a turtle can live all winter on one breath.

Be conservative and at the same time progressive. Examine all that is new, but before you adopt it test it by every standard that you can bring into comparison with it. Remember that you will probably not discover a great number of new truths, nor will you undermine and overthrow many of the commonly accepted theories and doctrines that have been enunciated in the past.

Be modest, then, and learn much from others, claiming very little as entirely new and your own. At the same time it is well to remember that this science and art of Physical Education or Training is in its infancy, in this country at least, and there is much work that is experimental and tentative.

Perhaps in no field of scientific research bearing directly on practical medicine is more to be discovered and demonstrated than in kinetic physiology. The influence of exercise on muscle, bone, nerve and connective tissue is not fully understood—in fact we are only working at the alphabet of the science as it will be developed. Much injury to progress has been caused by superficial observation and extravagant claims for "systems" and methods that had produced fair results apparently with a select few and were then loudly proclaimed as a complete scientific exposition of the whole subject when they barely rested on a single correct principle or physiological truth. When the enthusiasm of the originator had died out the illumination was found to be meteoric and a general distrust was established.

A quack in a community injures the reputation of every honest practitioner in it. Be content, then, to work a

great deal and claim very little. Have a scientific theory as a basis of your work but be ready to amend it at any time. Study your material and you will find so many facts to be classified and arranged that you will have little time to electrify the world by some universal specific. If you have no material and do no work you will have all the more time to invent some startling method that shall make you rich with the money of fools but leave science the poorer by a filching of her name and reputation.

CHAPTER II.

THE INSTRUMENTS TO BE USED AND THE RECORDS TO BE KEPT.

For taking the measures of a person several instruments are needed; but the outfit may be very simple. For several reasons the record should be taken and kept in the metric system: 1st. It is the scientific standard in use in all countries, and is in use in every other department of scientific investigation. 2d. It enables one to be very accurate without trouble, as the unit is very nearly one twenty-fifth of an inch. 3d. There are no fractions to complicate compilation, or computations, or records. 4th. It helps to introduce an improved system of weights and measures into general use, and, as the ordinary person has no idea whether his record in English units is large or small, but only judges by comparison with the standard, he will get as good an idea by the metric system.

The record book should be made of the best ledger paper and ruled transversely into spaces enough for all the items to be recorded. The perpendicular ruling can be made to divide the space into six columns, for the records when measurements are repeated. This will enable one to see at a glance what the change has been in any item, from time to time. If the space is economized, there will be plenty of room on the two pages that face together to record the measures of three individuals, six times each, and keep such items of history as should appear in such a book. It is advisable for each examiner to keep a private book for containing information of simply a personal nature, and for the guidance of the instructor in prescribing exercise.

This private record will give him an amount of material

for study and comparison, in a few years. The books should be bound in volumes of about 150 leaves, with heavy leather, as they are handled frequently. A second way of keeping the records, that has advantages in compiling the figures, or tabulating, has been devised by Dr. F. Swain. It consists of a card, with all the items, and room for two records of measurements. These cards are simply filed in alphabetical order and kept for reference. In tabulating results they are sorted over and placed in piles, according to any standard that may be taken—as height, or weight, etc. It is not a desirable form for a permanent record but, as the personal property of the examiner, is preferable to a book.

In the form of record book devised by Dr. Gulick, for use in Y. M. C. A. work, the historical data are placed at the top third of the page, the remainder being divided into a column for prescription, and several narrow columns for measures. The number of items measured is smaller than the list prescribed by the American Association for the Advancement of Physical Education.

It would seem that the card system of record could be used profitably in Y. M. C. A. work, as there is no special reason for permanently keeping the data except at some central bureau, where they can be tabulated for scientific purposes. In schools and colleges a permanent record is very important for history and comparison.

A method of duplicating a record for the benefit of the person measured has lately been suggested by Dr. E. Hitchcock, Jr., in connection with his graphic chart described later, and consists of a duplicate page to be inserted under the record page with a sheet of carbon paper between. By writing the record with a stiff pen the figures are duplicated on the chart page. This method saves much work in copying, and gives each man his record at once on a sheet together with the record of an average of 15,000 college men. This average represents more men of the student class than have ever been tabulated before, and is

therefore the best standard we now have for this class of cases. Another very satisfactory method of recording measures is by the author's anthropometric table bound in book form, and the measures indicated on it by dots and lines; or the actual record can be written at top or bottom and the graphic indications marked afterward. This gives a person looking over the record for special cases a comprehensive knowledge of the special form of the subject at a glance, where the examination of a list of measures even by an expert would be long and unsatisfactory. The private record should contain a careful record of personal peculiarities that may have a bearing on health and development. Any history of previous disease or accidental injury, even if recovery seems complete, should be recorded. Advice in regard to exercise and the results of the advice should be noted. This book should be a history of the person's physical welfare while he is under observation, and thus correspond to a physician's case-book. The examiner will learn more from this record than from the book recording size and strength.

The following instruments are needed:

1. A set of scales, with high bar for convenience in reading. These are made with metric graduation.

2. A graduated pole, Fig. 1, with a slide moving at right angles on it for taking heights. The arm of the slide should not be over 125^{mm}. long. The pole may have the metric system marked on one side, and the English on the other, like the one shown in the cut. A very convenient method of taking heights is by using two meter sticks, on one of which is fixed at the end an arm of metal, 2^{mm}. thick and 18^{mm}. wide and 125^{mm}. long. A slide bearing a similar arm is made to run closely on the stick. The height is readily taken by holding the ends of the sticks together by the left hand while the right lowers the slide to the top of the head. Care must be taken to have the sticks perpendicular. The height sitting and the height of pubes and knee are taken with the one stick, which is much lighter

and more readily handled than the long pole. The meter stick, with slide, can then be used for taking the breadths.

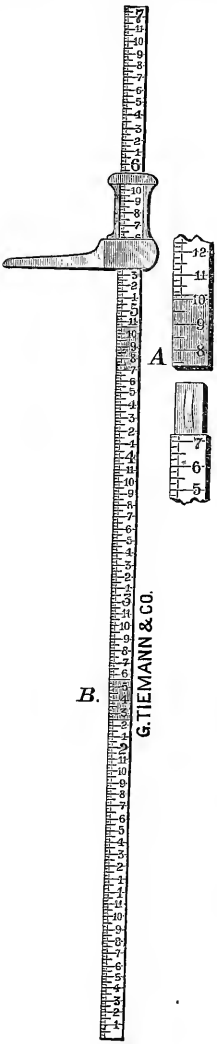


Fig. 1.

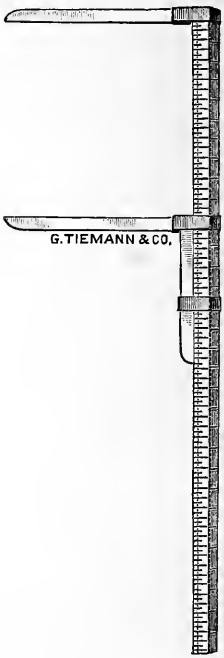


Fig. 2.

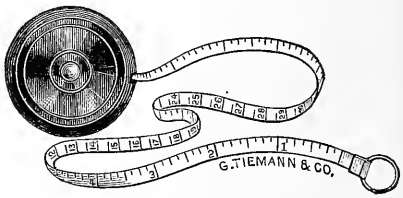


Fig. 3.

3. A pair of slide calipers, Fig. 2, for taking breadths. This must have a capacity of 500^{mm}.

4. A tape measure of steel or cotton, Fig. 3. The metal is uncomfortable to the skin, but does not stretch and can be kept clean. A linen tape stretches on being moistened, and many subjects will sweat so freely as to wet a cloth tape. A painted tape is about as unpleasant to the touch as one of steel, and for the above reasons I always use a steel tape.

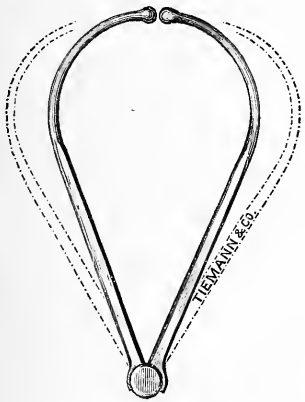


Fig. 4.

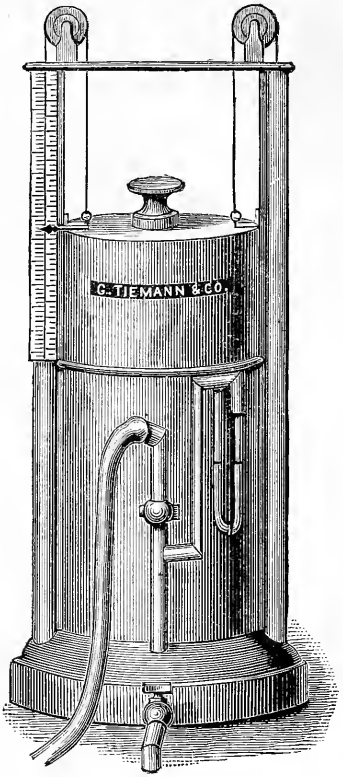


Fig. 5.

A little device is made by the Narragansett Machine Co., at the suggestion of Dr. Gulick, for attachment to the end of a tape to indicate the proper tension, so that the pressure may be always alike. It is a good device for the

beginner, but useless after practice has given a habit in making the tension.

5. Calipers for taking depths, Fig. 4, and, in some cases, breadth of chest. These may be of wood or metal and should have large extremities, so that a slight variation in pressure will not vary the record greatly by indenting the flesh. An index should be on the instrument, for reading while in position.

6. A capacity spirometer, Fig. 5, for recording the amount of air that can be inhaled and then exhaled, or the complemental, tidal, and supplemental air of respiration.

Hutchinson's wet spirometer is considered the most reliable instrument of the kind.

7. A stethometer or pressure spirometer is used by some persons, but is utterly worthless as far as information elicited by it is concerned. A person may blow by means of a rubber tube and suitable mouthpiece into an ordinary steam guage that is made for recording low pressures, or an instrument devised by the author may be used. A piece of glass tubing of 5^{mm}. diameter is bent into the form of a right-angled triangle, having one angle of about $35°$. The side adjacent to this angle should be about 400^{mm}. long and should be horizontal when the triangle is fixed against a flat wall for support. A rubber tube with a glass mouthpiece is attached to the short side, and mercury is drawn in to fill the horizontal part. Now, by blowing into the mouthpiece, the mercury is forced up the hypothenuse of the triangle.

The graduation is easily made by measuring the perpendicular line from the base to any point in the hypothenuse, and affixing a scale to the support back of the tube. The pressure will then be indicated in millimeters of mercury column.

8. A hand dynamometer, Fig. 6, for taking the strength of the flexor muscles of the forearm.

There are several forms of this instrument, the more common ones being the oval (Fig. 6) and the form with

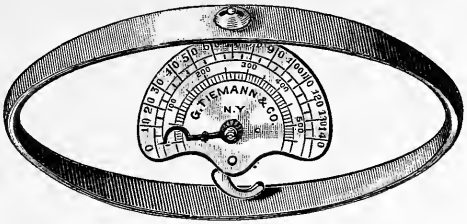


Fig. 6.

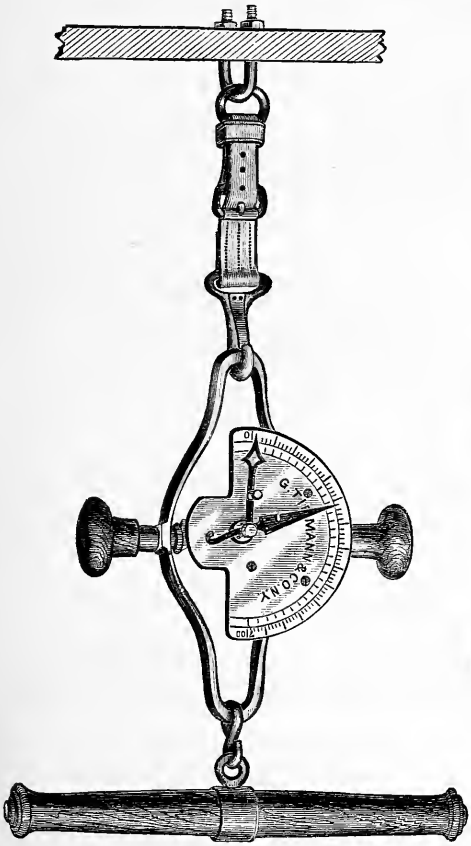


Fig. 7.

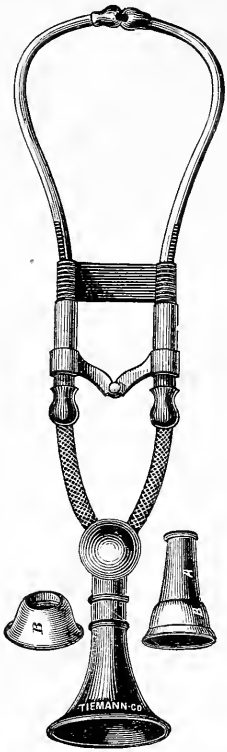


Fig. 8.

the two sides always parallel—the resistance being two spiral springs. This second form gives all the fingers an equal opportunity to exert their pressure.

9. Dynamometer for lifting with the back and legs, and taking the strength of the pectorals and retractors of the shoulders, Fig. 7. This instrument may be replaced for the first two tests by a lifting machine with spiral spring resistance, and a graduated index applied from actual tests. The advantage of this latter form is the quick adjustment to the height of the person.

10. Parallel bars for testing triceps extensor in "Push up." A short pair of bars, about 750^{mm}. long, attached to a frame with suitable braces, and made to move up and down against the wall, in being adjusted to any height desired, can be used for this test and also for the "Pull up," or test of flexors of the upper arm. Otherwise a horizontal bar, trapeze bar, or pair of swing rings must be used for this last test.

11. A stethoscope for listening to heart and lung sounds, etc., Fig. 8. Camman's binaural is a suitable instrument. The soft rubber bell (B) is useful at times to secure perfect coaptation to the surface of the chest. It requires some practice to secure all the advantages that a stethoscope can give, as the pressure of the nib in the ear is a distraction of the attention, and any slight movement of the fingers on the instrument causes vibrations that are not understood. If the examiner wishes to hear the valvular sounds of the heart, without the interference of muscular vibration sounds, he can interpose a thin cloth between the bell and skin, but in general the instrument should be placed directly against the surface of the body.

In addition to the above mentioned instruments the following are useful at times and for special work :

12. A sphygmograph, or kymograph, for taking pulse tracings, Dudgeon's instrument is perhaps as satisfactory as any. It is small, easily applied, can be carried in the pocket and used in the gymnasium as well as in the

office. It can not be applied to all pulsating surfaces. Marey's instrument is used to some extent, but the pneumatic kymograph is employed in all physiological laboratories, and does very satisfactory work.

13. A laryngoscope, rhinoscope, otoscope and tuning fork, for examining the throat, nose and ears.

14. A Clinical thermometer.

15. A Pleximeter and percussor. Figs. 9, 10.

A 16. Microscope of 20^{mm}. focal distance for examining the skin.

Fig. 9.

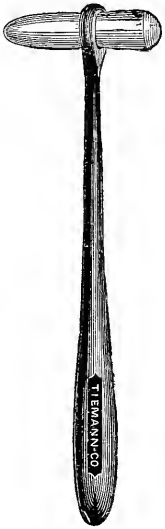


Fig. 10.

17. A case of urinary tests for sugar and albumen.

18. Test worsteds, glasses, and charts, for examination of eyes for color blindness and errors of refraction.

These instruments can be obtained of any first-class dealer in surgical instruments and optical goods except 17 which can be obtained of Parke, Davis & Co., or other manufacturing chemists and druggists.

A universal dynamometer has been invented by Dr. J.

H. Kellogg, which deserves more than a mere mention for it is destined to be used in modified form by every person practicing anthropometry, and by many physicians in diagnosis and determination of the actual progress of certain cases. Its use will supply the place of all the dynamometers mentioned above, while its cost will be comparatively small.

The instrument may be briefly described in the words of Dr. Kellogg, transcribed from a paper published in the Transactions of the Michigan State Medical Society, 1888:

"1. A cistern about two-thirds filled with mercury, the remaining space being filled with water.

"2. A glass tube of a caliber of about one thirty-second of an inch and six feet in height.

"3. A rubber bulb connected by a tube with the space above the mercury in the cistern, and both filled with water.

"4. A bottle partly filled with water, placed two or three feet above the cistern and connected with the upper part of it by a rubber tube. A pinch cock controls the connection between the bottle and the cistern. The purpose of this arrangement is to keep the upper portion of the cistern filled with water, and to raise the height of the column to any desired point before applying pressure to the bulb when it is desirable to do so.

"5. An adjustable, graduated scale erected beside the glass tube and reaching to the level of the mercury in the cistern.

"6. A framework by which the apparatus is sustained. See Fig. 23, page 36.

"In use compression is made on the rubber bulb by which water is forced into the cistern displacing an equal quantity of mercury which rises in the tube until a height is reached at which the pressure upon the inside of the bulb is equivalent to that upon the outside.

"By means of simple arrangements for the purpose, the strength of every group of muscles in the body, except the

smallest and most inaccessible, can be readily tested by this apparatus."

The following cuts will illustrate the method of using the apparatus for some of the common tests.

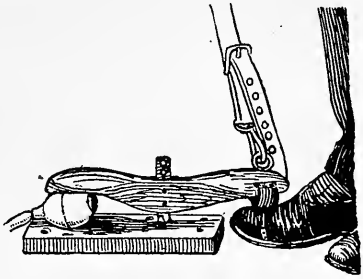


Fig. 11.

"Fig. 11 shows the method of testing the anterior muscles of the leg. It is simply a double lever moving

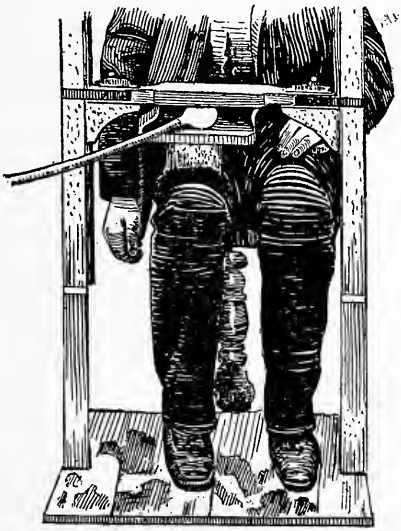


Fig. 12.

upon an axis in the center, the bulb of the instrument being placed under one end and the toe of the foot under the other end. The test is made by raising the toe.

"Fig. 12 shows the method of testing the muscles of the calf. The bulb is placed beneath a bar secured to two uprights, being supported by a flat piece which rests upon the knee. By raising the leg by the toe, the muscles of the calf are brought into action.

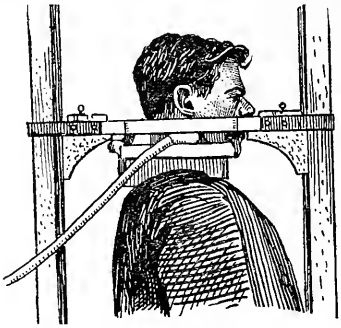


Fig. 13.

"Fig. 13 shows the method of testing the muscles of the shoulders.

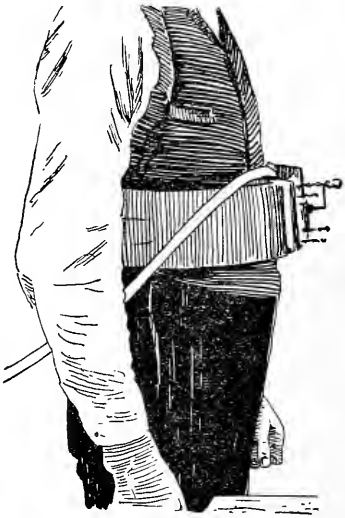


Fig. 14.

"Fig. 14 shows the method of testing the diaphragm. The apparatus used is seen more distinctly in Fig. 15. It consists simply of a belt carrying two rigid plates, one fixed and the other movable, secured together by rubber bands. The screw which passes through the fixed belt works against another movable plate on the inside of the fixed plate, and furnishes a means of fine adjustment. In use the belt is put around the body so that the movable plate falls just below the ribs. After attaching the belt the screw is turned in until the mercury rises in the column to ten centimeters, then the patient takes a deep abdominal breath. The same instrument may be used for testing the strength of the serratus magnus, by placing it at the side instead of the front.

Fig. 16.

"Fig. 16 shows the method of testing the pronators and supinators.

"Fig. 17 shows the method of testing the force with which the hands can be pressed together.

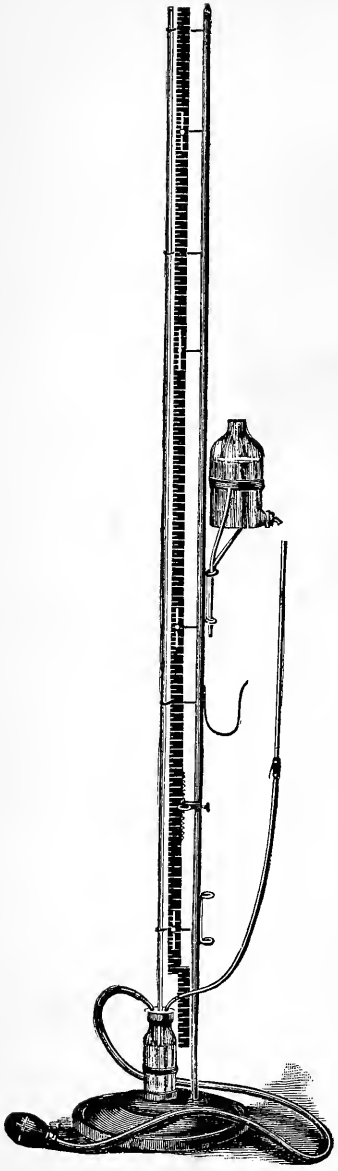


Fig. 38.
Universal Mercurial Dynamometer.

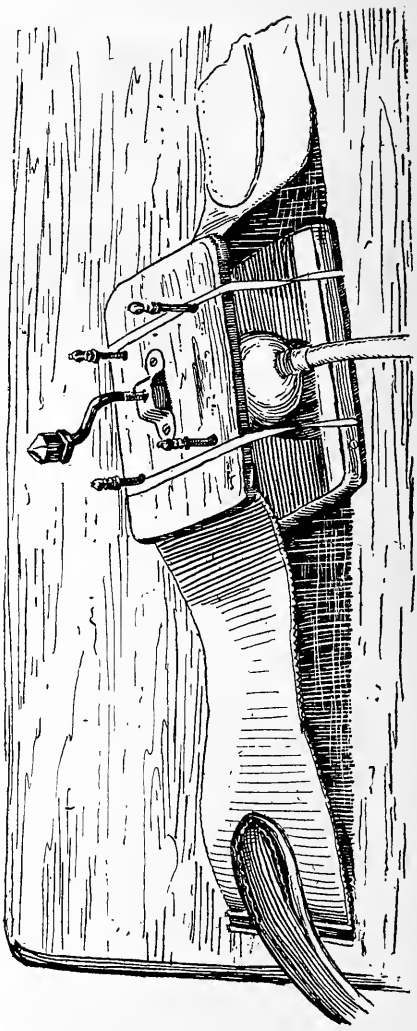


Fig. 15.

"Fig. 18 shows the method of testing the flexor muscles of the arms. The extensors and flexors of the legs are tested by similar means.

Fig. 17.

"A strap is thrown over the shoulders, with the body bent forward at an angle of 45 degrees for the purpose of testing the strength of the muscles of the back. A similar arrangement attached to the wall is used to test the anterior and lateral muscles of the trunk, also the muscles of the neck. You can readily see how by a simple contrivance all the principal groups of muscles in the body may be tested. My instrument has a mercurial tube 10 feet long. A much shorter tube will answer the purpose by having the top of the tube closed."

Some modifications of this machine will adapt it to general use. If a closed tube seven or eight feet long be used the top may be doubled on the main part for two feet to save space and make the apparatus more portable. If the calibre of the tube be small there will be no need of the hydraulic pressure from the bottle of water shown in the illustration, Fig. 23. For ordinary tests there will be a record of less than 200 lbs., except for back and legs. To take these heavier tests a system of levers will be required and can be readily arranged.

One point in the working of this machine that must be

secured before perfect accuracy will be reached is the condition of similar pressure surfaces on the bulb for every

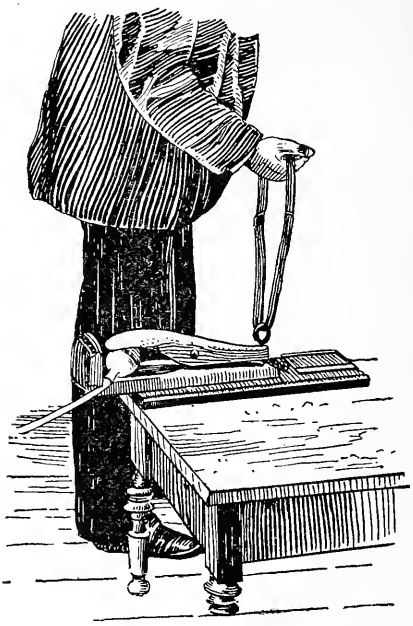


Fig. 18.

test. Then the record can be read in a similar unit for each test and will be absolute. This will enable one to compare or tabulate records made on different machines of the same kind, as we now compare weights taken on different scales. The author has devised an arrangement that will apparently meet this requirement for the majority of tests but must have practical experience with the apparatus before announcing a complete machine. Any new device that will enable one to secure accurate tests of strength will assist greatly in practical anthropometry and the prescription of exercise.

CHAPTER III.

WHAT TO MEASURE AND HOW TO MEASURE.

In making a physical examination and measurement it is well to have the subject entirely nude, and consequently the temperature of the room must be kept as high as 75°. A good method of procedure is to take the weight and height measurements, then the lengths, then the breadths, then the depths, then the girths, and finally the strength tests. During the measurement the examiner should be alert in noticing any peculiarity or deformity or disease or external indication of disease. The subject may then dress the lower extremities, and the minute examination of the chest be continued.

When the examination is made for an institution, and is to include the measurement of many men, the services of a clerk will save at least half of the time and leave the examiner free from merely clerical work, and enable him to give all his attention to the examination in hand. With such assistance the fifty measurements can easily be made, after a little experience, in five or six minutes, and from fifteen to twenty minutes should be devoted to each individual; the latter amount if advice in regard to methods and forms of exercise, and instruction concerning diet, bathing, sleep, etc., is to be given at the time of the measurement. To economize time the specially weak or undeveloped parts should be pointed out to the subject himself and the simplest exercises for developing those parts be recommended and illustrated if possible.

A greater advantage will come from exercise if the object of the exercise is known than if a routine is simply followed without interest. A muscle will undoubtedly

grow faster if watched and made the object of thought during its activity, and if attention is turned to it during its period of rest. The reason of this is found in the interrelation of the trophic and voluntary nerves.

A proof of the influence of volition over trophic changes has lately been made by Prof. A. Lehmann of Copenhagen, who has employed a thermometer capable of showing differences of .02° F. When Lehmann or the person who aided him in his experiments, concentrated his mind on the idea of an increased temperature of the hand, it rose .036° to 0.108° F.; but when the attention was concentrated on the idea of a greater warmth of the fingers alone, the temperature of the hand fell 0.756° to 0.936° F.—*Hospital-stidende*, No. 3, 1890. *Copenhagen.*

The hygienic instruction can be given by lecture to whole classes, and a case needing special care and supervision can be asked to come to your office at some other hour when you will have time to go over the case thoroughly and examine into all the details of his habits, a knowledge of which will alone enable you to give the best advice.

If you are examining many cases in succession, you will need to possess a quick memory of faces and facts, or some notes will have to be taken at the time of examination, that will recall the existing conditions in each case. It is well to train the memory in this matter, but to take careful notes to fall back upon. A client will feel that you remember him and have given his case thought, if you can show him that you know just what his condition was when you saw him last.

The number of items measured is not of so much importance as the thoroughness of the work done, and the care and judgment displayed in discovering weak parts that can be strengthened, and recommending the proper remedies. But I would advise a strict adherence to the advanced standard of measurements recommended by the American Association for the Advancement of Physical Education and for three reasons: 1st, to take this complete list would re-

quire only about two minutes longer time than for the method of twenty items. 2nd, the completeness of the record will be a satisfaction to all parties. 3rd, uniformity of methods is of great importance in giving scientific value to work of this kind. Then, if a person has a special desire to ride some hobby of his own and take such measurements as the horizental length, the occipito-mental diameter of the head and the length of the os calcis, all of which points are of some importance and have a bearing on anthropology and practical anthropometry, he is at liberty to do so.

Below is given in full the report of the committee on statistics appointed by the American Association in 1885.

Report of the Committee on Statistics, appointed by the American Association in 1885, giving the detailed method of securing measurements, tests, and the condition of the human body.

ANTHROPOMETRIC MEASUREMENTS.

NUMBER. — In order to secure privacy the individual should be entered in the record book by number. As a means of identification the number can be entered in an alphabetical index book opposite the corresponding name, as:

Smith, John H., 526.

For further convenience it is advisable to enter the name in a numerical index book opposite the corresponding number, as:

526, John H. Smith.

DATE.—Record the year, month, day and hour, as: Jan., '86, 12, 9 A.M. Where perfect accuracy is desired, note should be made of the time that has elapsed since eating, the occupation of previous hours, and of the temperature of the room.

AGE.—Record years and months, as: 21, 9, *i. e.*, twenty-one years and nine months.

Weight.—The weight of the body should be taken without clothes. Where this is impracticable the weight of the clothes should be deducted.

Height.—The height should be taken without shoes and with the head uncovered. The head and figure should be held easily erect, and the heels together. This position is best secured by bringing the heels, the buttocks, the spine between the shoulders and the back of the head, in contact with the measuring rod.

Height of Knee.—The subject should place one foot on a box or chair of such a height that the knee is bent at a right angle. A box about 12 inches high is suitable for adults. Press a ruler upwards with a force of about one pound against the ham string tendons close to the calf of the leg. See that the ruler is held in a position at right angles to the vertical rod, and measure the height of the top of the ruler from the box.

Height Sitting.—Let the subject sit on a hard, flat surface about 12 inches high, such as afforded by a box or chair, with the head and figure easily erect so that the measuring rod will touch the body at the buttocks, between the shoulders, and at the back of the head. Measure the distance from the box to the vertex.

Height of Pubes. — With the subject standing easily erect on the box or floor, measure up to the lower edge of the pubic bone.

Height of Crotch.—With the subject standing easily erect on the box or floor facing the vertical rod, press a ruler firmly against the perineum (crotch) and measure the height of the top of the ruler.

Height of Navel.—With the figure and head of the subject erect, measure the height of the centre of the cicatrix.

Height of Sternum.—With the figure and head of the subject erect, measure the height of the interclavicular notch.

All girths should be made on the skin itself at right

angles to the axis of the body or limb at the point of measurement. No oblique measurements are taken.

GIRTH OF HEAD.—This measurement should be taken around the head with the tape at the upper edge of the eye brows, over the supra orbital and occipital prominences.

GIRTH OF NECK.—With the head of the subject erect, pass the tape around the neck half way between the head and body, or just below the "Adam's Apple."

GIRTH OF CHEST.—Pass the tape around the chest so that it shall embrace the scapulæ and cover the nipple. The arms of the subject should be held in a horizontal position while the tape is being adjusted and then allowed to hang naturally at the sides. Take the girth here before and after inflation.

Where it is desirable to test the elasticity or extreme mobility of the walls of the chest, a third measurement may be taken after the air has been forced out and the chest contracted to its greatest extent. To test the respiratory power, independent of muscular development, pass the tape around the body below the pectoral line and the inferior angles of the scapulæ, so that the upper edge shall be two inches below the nipples. Take the girth here before and after inflation.

GIRTH OF WAIST.—The waist should be measured at the smallest part after a natural expiration.

GIRTH OF HIPS.—The subject should stand erect with feet together. Pass the tape around the hips above the pubes over the trochanters and the glutei muscles.

GIRTH OF THIGHS.—With the feet of the subject about six inches apart, the muscles set just enough to sustain the equilibrium of the body and the weight distributed equally to each leg, in gluteal fold measure around the thigh just below the nates.

GIRTH OF KNEE.—With the knee of the subject straight and the weight of the body equally supported on both legs, measure over the centre of the patella.

GIRTH OF CALF.—With the heels down and the weight

of the body supported equally on both feet, the tape should be placed around the largest part of the calf.

GIRTH OF INSTEP.—Measure around the instep at right angles with the top of the foot, passing a point at the bottom of the foot midway between the end of the great toe and back of the heel.

GIRTH OF UPPER ARM.—With the arm of subject bent hard at elbow, firmly contracting the biceps and held away from the body in a horizontal position, pass the tape around the greatest prominence. If desirable to find the girth of the upper arm when the biceps is not contracted, the arm should be held in a horizontal position and measured around the most prominent part.

GIRTH OF ELBOW.—Taken around the internal condyle of the humerus while the arm of the subject is straight, with the muscles of the forearm relaxed.

GIRTH OF FOREARM.—Taken around the largest part. The fist should be firmly clinched and the palm of the hand turned upward.

GIRTH OF WRIST.—With the hands of the subject open and the muscles of the forearm relaxed, measure between the styloid process and the hand.

BREADTH OF HEAD.—The breadth of head should be taken at the broadest part. In taking the breadth measurements, stand behind the subject.

BREADTH OF NECK.—Taken at the narrowest part with the head of the subject erect and the muscles of the neck relaxed.

BREADTH OF SHOULDERS.—With the subject standing in a natural position, elbows at the sides, shoulders neither dropped forward nor braced backward, measure the broadest part two inches below the acromion processes.

BREADTH OF WAIST.—Taken at the narrowest part.

BREADTH OF HIPS.—Measure the widest part over the trochanters, while the subject stands with feet together, the weight resting equally on both legs.

BREADTH OF NIPPLES.—Taken from centre to centre with the chest in a natural position.

Depth of Chest.—Taken after a natural inspiration. Place one foot of the calipers on the sternum midway between the nipples, and the other foot on the spine at such a point that the line of measurement is at right angles with the axis of the spinal column. When it is desirable to ascertain the extent of the antero-posterior movement of the chest, measurements may be taken from the same points after the fullest inspiration and after the fullest expiration.

Depth of Abdomen.—Place one foot of the calipers immediately above the navel, the other on the spine at such a point that the line of measurement is at right angles to the axis of the spinal column.

Length of Shoulder to Elbow.—With the arm of the subject bent sharply at the elbow and held at the side, measure from the top of the acromion process to the olecranon. Care should be taken that the measuring rod is parallel with the humerus and not with the external surface of the arm.

Length from Elbow to Finger Tip.—With the arm of the subject bent sharply at the elbow and the rod resting on back of arm and hand, measure from the olecranon process to the tip of the middle finger.

Length of Foot.—Take the extreme length of foot from the end of the first or second toe to the back of the heel, about one inch from the surface upon which the foot rests.

Stretch of Arms.—With the arms of subject stretched out horizontally so that both hands and shoulders are in a line, with one middle finger and the zero end of the measuring rod pressed against the wall, note the point to which the other middle finger tip reaches.

Horizontal Length.—With the heels of the subject pressed hard against a perpendicular wall, with arms at the sides and body resting naturally on a horizontal plane, measure the distance of the apex of the head from the wall.

Capacity of Lungs.—The subject after loosening the clothing about the chest and taking a full inspiration, filling the lungs to their utmost capacity, should blow slowly into the spirometer. Two or three trials may be allowed.

Expiratory Strength.—As before, the subject after loosening the clothing about the chest and filling the lungs completely, should blow with one blast into the manometer. Care should be taken that no air is allowed to escape at the sides of the mouth, and that in expelling the air all the muscles of expiration are brought into play.

Strength of Back.—The subject, standing upon the iron foot-rest with the dynometer so arranged that when grasping the handles with both hands his body will be inclined forward at an angle of 60°, should take a full breath and, without bending the knees, give one hard lift, mostly with the back.

Strength of Legs.—The subject while standing on the foot-rest with body and head erect, and chest thrown forward, should sink down, by bending the knees, until the handle grasped rests against the thighs, then taking a full breath, he should lift hard principally with the legs, using the hands to hold the handle in place.

Strength of Chest.—The subject with his elbows extended at the sides until the forearms are on the same horizontal plane and holding the dynamometer so that the dial will face outward and the indicator point upward, should take a full breath and push vigorously against the handles, allowing the back of the instrument to press on the chest.

Strength of Upper Arms, Triceps.—The subject, while holding the position of rest upon the parallel bars, supporting his weight with arms straight, should let the body down until the chin is level with the bars, and then push it up again until the arms are fully extended. Note the number of times that he can lift himself in this manner.

Strength of Upper Arms, Biceps.—The subject should

grasp a horizontal bar or pair of rings and hang with the feet clear from the floor while the arms are extended. Note the number of times that he can haul his body up until his chin touches the bar or ring.

Strength of Forearms.—The subject, while holding the dynamometer so that the dial is turned inward, should squeeze the spring as hard as possible, first with the right hand then with the left. The strength of the muscles between the shoulders may be tested with the same instrument. The subject, while holding the dynamometer on a level with the chest, should grasp it with handles and pull with both arms from the centre outward.

Pilosity.—Note the amount of hair on the body and limbs, excluding the head, face and pubes.

Color of Hair.—*Light* (Very Fair, Fair, Light Brown, Brown), *Dark* (Dark Brown, Black Brown, Black). *Red* (Red Brown, Red, Golden).

Color of Eyes.—*Light* (Dark Blue, Blue, Light Blue). *Dark* (Light Brown, Brown, Dark Brown, Black). *Mixed* (Gray, Green).

D. A. Sargent,
Edw. Hitchcock,
Wm. G. Anderson,
} *Committee.*

The following criticisms of this Report, that now stands as the official list of the Association, are presented, and an effort will be made at the next annual meeting to have the list revised, and the changes here suggested incorporated.

The height of knee should be a bone measurement, and the most convenient point is to top of the fibula, as the subject is sitting, and this record can be taken immediately before or after "height sitting." The present method is very inaccurate and unscientific, because the length will vary from two to five cm., according to the tension of the hamstring muscles, which are not always under the direct control of the will with the leg in the position indicated and can not be relaxed in every case without great care.

The head of the fibula can be easily found in nearly every case, and in those where it can not be located, the head of the tibia can be found, and the head of the fibula is about ten mm. shorter. The "height of crotch" need not be taken, for obvious reasons, when we have "height of pubes."

Another height-measurement advised by the Y. M. C. A. committee is the length of trunk which is measured from the buttocks to the point of the seventh spinous process, or vertebra prominens, with the subject in the same position as for taking the height sitting. It is not always easy to decide with certainty which is the seventh spinous process; but it is usually the most prominent one, and of several that seem of equal prominence, it is usually the lowest.

The length of trunk, depth of chest and breadth of chest are three factors, that, multiplied together, may roughly be considered to represent the "vital capacity" of a person. We can get the length of trunk in another way—by subtracting the height of sternum from total height, which will give the length of head and neck; and, by subtracting this remainder from the height sitting we shall have the length of trunk.

I can discover no adequate reason for taking the horizontal length. It consumes considerable time, is a difficult measurement to take correctly, and exceedingly awkward for the subject; its average relation to the total height is a matter of anatomical record; and, in the special case it can easily be estimated by any examiner, of even limited experience, by the amount of lordosis and flexibility of the spine. Each person should take a few measurements of subjects with hollow backs, in order to get an idea of the variation in these cases; but further than this there is no utility in the recording of this item. In taking girth of elbow the object is to discover the development of the tissues that lie between the muscles measured in the arm girth and those in the forearm girth. The muscles of the

forearm have their origin on the internal and external condyles, without the intervention of tendon. A measurement over the condyles is therefore essentially the same as the forearm girth and will in practice differ from it by only about two centimeters. We would discover the condition of the whole arm, and the elbow girth taken over the condyle adds nothing to our information. On the contrary, if we measure around the smallest part of the elbow we know how well the tissues are developed between the muscles of the arm and those of the forearm. It is not a muscle girth in the latter case ; in the former it is.

The breadth of shoulders should be a bone measurement as nearly as possible ; for I conceive the object of it to be the determination of the extent of the bone tissue to which the more important muscles of the upper extremities and thorax are attached. If we measure below the acromion, as directed, we give a person credit for broad shoulders simply because he has a thick deltoid muscle and the muscles of the chest and arm add to the record, in such cases, by making the arm hang at an angle instead of perpendicularly, as expected. It would be nearly as scientific to include the arms in the waist breadth, and then let the subject stand with arms akimbo.

The breadth of chest is of more importance than breadth of nipples and should be taken at full natural inspiration in the axillory regions, on a level with the nipples. For ordinary cases the measurement can be taken with the same instrument as the other breadths ; but in very fat or muscular persons the calipers used in taking depths should be used.

The expiratory strength, as ordinarily taken, is misleading and untrustworthy. The intention is to gain some knowledge of the condition of the accessory muscles of expiration ; for, in ordinary expiration there is little or no activity of muscles but rather a letting go or suspension of muscular effort. (See Foster. Phys. ed. 1883, p. 315.) Now, when the subject is asked to blow as hard as he can into the apparatus, and keep the throat open, as in respira-

tion, he will involuntarily close the pharynx with the back of the tongue and palate, and then bring the muscles of the cheeks and lips into active contraction, and, with a few efforts, acquire such skill as to rival the cornet player in the record secured.

For those who are making a special study of athletes a measurement suggested by Dr. Savage of the Berkeley Lyceum Gym. is worthy of notice, namely; the length of the os calcis; this being the lever arm of the muscles that extend the foot; its relation to the metatarsal and phalangeal portion is doubtless of importance in determining the ability for such exercises as running, walking, jumping, etc.

Some points in minute anthropometry have been suggested by various specialists, but obviously such work should be left to those who wish to study some particular phase of the subject.

Dr. F. Swain has proposed to measure the height of ear, girth of ankles and hands, depth of pelvis, neck and head, length of hands. Mr. R. J. Roberts considers the girth around the shoulders at point of shoulder breadth of great importance. Dr. E. Mosher thinks that depth of chest should be a double measurement, showing thickness of right and left chest; and the suggestion is a good one, because, in many cases the sternum is depressed and the record, if made strictly by rule, would be smaller than the subject deserves. In such cases I have put one foot of the calipers on the proper point behind, and brought the other out to a point not quite in line with a ruler laid across the chest. Dr. Mosher's method would show any asymmetry of the chest.

The French police regulations require a minute measurement of the ear and middle finger for identification of criminals if they are arrested a second time. These measures help in classifying the photographs that are taken so that they can be readily found among thousands. Some form of anthropometrical tests can no doubt be made more serviceable in establishing identity in a "rogue's gallery"

than photography. The physiological picture of a man as shown on a graphic chart is sure to retain some characteristic feature, whatever may be his condition.

Photography may be wisely used as an adjunct of anthropometry. Since Prof. Muybridge made his wonderful pictures of animal locomotion by instantaneous process the value of a photograph to show physical deficiencies as well as excellence has been established. It makes a record in an artistic way that is made by tape and calipers in a mathematical or scientific way. Already at some of the better equipped gymnasiums, like the Hemenway in Cambridge, photography is made to assist in preserving the record of a man's physical condition.

The strength tests that may be taken are more in number than the muscle girths taken in the above list and a table of strength tests may be made that would correspond to the author's anthropometric table. The quality of the muscles could be graphically shown on this, side by side with the girths. Uniformity of method in testing strength will soon furnish material for such a table. Care must be used to guard against strain and over-exertion in securing data of strength.

The tests for accuracy and strength may be made by the record in a series of athletic exercises and show something of the nerve training that the subject has had ;—in other words, the self-controlled power. In a person we may test the strength of fifty groups of muscles acting separately so far as possible and, while our record may be high, we may still have a very inadequate estimate of the coördinated power—the real strength of the individual, which may be small. Probably the best exhibit of a man's power is seen in such games as foot ball where the strength of every muscle is tested both as to its own quality and its adjustment to other muscular groups and to mental stimuli.

An organ may work correctly but slowly. The eye of one person sees at a glance what the eye of a second person would require seconds to reveal, and yet the eye

of the latter may be perfect according to every test of the oculist. It is so with hearing. The time required between hearing and perceiving sounds and giving a signal is .12 to .18 of a second. Higher tones require slightly less time than deeper ones. Noises are heard quickest.*

A distinguished teacher recently told me that he had called a certain boy stupid until he discovered that the boy was merely slow in his sense of hearing. Since that time he has studied boys whose perceptive faculties seemed dull and has found that a large percentage of them are deficient mainly in hearing a question that is put rapidly to them. A device that will test the speed of the action of the eye and ear correctly within moderate limits of accuracy will be of great practical importance in an educational as well as scientific aspect. Physical education must bring up to a higher plane of activity each physical function that is found to be deficient. To do this the examiner must be ever alert to discover undeveloped functions and inventive ability will be frequently required to solve the problems presented.

Another refinement of anthropometry is taking the specific gravity of a man. This may not be a feasible addition to practical anthropometry but for minute study may afford an interesting field of investigation. The record can be taken by immersing the subject to the face or any suitable point in a reservoir of water that is situated on a scale for weighing. From the weights of the reservoir full of water, the displaced water and the immersed subject in the reservoir the specific gravity has been calculated. The fact has been often noted that men of small girths often show a weight far above what would be fairly estimated, but as yet there has been no scientific study of this class of cases to discover the relation of high specific gravity to health, strength, endurance or longevity. The specific gravity of any body is represented by the quotient obtained by dividing the weight of the body in air by the loss of weight when weighed in water.

* Kries and Auerbach, quoted by Thompson.

CHAPTER IV.

PERSONAL HISTORY AND EXAMINATION OF SPECIAL SENSES.

The historical data that should be gathered at each examination are of varied character, and of the highest importance. It gives the examiner an idea, not only of the immediate weaknesses that are to be met and combated by proper advice and training, but it places the law of heredity in bold relief, and enables the counsel to be far-reaching in its results.

For instance: with a record of tuberculosis, extending through two or more generations, there would seem to be sufficient warrant for advising not only the thorough development of the chest, but the careful avoidance of excessive exercise, such as would be required in many athletic sports that would seem, at first thought, especially suitable for a person of consumptive diathesis. To know a man well you must know his father and grandfather. This negative side of training and physical education has received very little attention from practical teachers outside of the so-called Delsarte system, where it has run riot. The conservation of force is the foundation of the Delsarte system, but only profound ignorance of the physiologic laws of growth and development could excuse the building upon such a principle.

Growth and organic perfection are gained only by a use of all the tissues—but use is one thing and abuse quite another. The eye is developed and improved by a repeated use in distinguishing colors, shapes and sizes; but a long-continued strain of the eyes over a Greek or German text is not exactly beneficial, as the spectacle-mounted noses of our students, especially the Germans, bear witness. So,

while a good run in the open air may be beneficial to a person of sensitive or weakened lung tissue, it does not follow that training for a mile run or a "hare-and-hounds" chase would be.

The condition of the subject during the previous years of his life is valuable in making a prognosis or a judgment of the future history of the case, and in deciding what quality of endurance the subject possesses, for the violent exercise of one man is a mere nothing for another. The boy who comes to school from the farm or workshop may be no better developed than his classmate, who has never known what physical work is, and yet be able to endure twice as much prolonged physical exertion. His life has been spent out of doors, and he takes kindly to outdoor sports, running, foot-ball, boating, etc.; or, if his life has been in a shop where skilled manipulation has engaged his energy, he prefers gymnastic exercises, becomes an adept at club swinging, fencing, etc., or a good performer on the bars, rings and other apparatus.

The city-bred boy has a latent aptitude for anything, and with proper training is a strong competitor with his country classmate in every line of athletics or gymnastics, but his exercise will need to be progressive, or he will suffer from local strains that may affect vital organs.

If, on the other hand, the history discloses a previous life of activity and physical hardship, and the plan of life is directed toward sedentary pursuits, the recommendation must be toward retrogressive exercise. A man with benign hypertrophy of the heart is not in the best condition for sitting at a desk all day—there will be too much local congestion for good brain work, or the metamorphosis of muscular tissue in the heart itself will end in fatty degeneration, or softening, and impaired vitality result. This is undoubtedly the reason for the numerous cases of functional and organic diseases of the heart that are found among ex-champions.

The history may also disclose a tendency to disease in

the subject himself, that will modify the prescription of exercise very materially, if the examiner is alive to the exigencies of the case and informed as to its requirements.

But, without citing further examples of the advantages, nay, necessity of a full history of each case, let us turn to the question of what points in history should be recorded.

On the record book, in connection with the measures, the subject's name and birthplace should be kept—there is no reason for secrecy about these matters.—It is also well to add the birthplace of parents and grandparents to this general record, for it makes the material valuable in studying the effect of location or environment in differentiating classes or social groups; the occupation of the father, the resemblance in physical build to father's or mother's family; past exercise in work and recreation, pulse rate, color of hair and eyes, vision and hearing, use of tobacco and stimulants. In the private book should be recorded the cause of death of either parent if not living, any disease that has been common in the family (it is better not to use the word hereditary in this connection) such as lung diseases, heart diseases, rheumatism, neuroses, Bright's disease, cancer, scrofula, varicose veins, dyspepsia, diarrhœa, constipation, catarrh, etc.; also any disease that may be found affecting the subject, as varicocele, rheumatism, synovitis, etc., any deformity and its cause, if discoverable; any injury in the way of broken bones, surgical operations, strains, etc.; any previous severe illness, such as peritonitis, zymotic fevers, etc.; any tendency to deranged functional activity, as constipation, biliousness, indigestion, insomnia, etc.

In this connection it may be well to call attention to the rule that, if a child strongly resembles in physical build the side of the family that has no hereditary taint, the other side having some pathological diathesis or dyscrasia, the probability of his inheriting the disease is diminished.

It is well to record the special kind of athletic or gymnastic work that has been taken, and whether this has been under the personal direction of a teacher or trainer. If

there is any lesion of the heart or other organs that has been due to or been attributed to athletic or gymnastic work under supervision, look up the instructor and get the previous history of the case. You may find that the so-called instructor or trainer was an ex-prize fighter or dilapidated "bummer," but, if so, use him to discredit the popular trust in ignorance. If he does know his business, he will perhaps be able to enlighten you as to the cause of the trouble.

The record of color-blindness* should be kept, not as a disease, but as a peculiarity that would render the subject unfit for some occupations. In many cases of supposed color-blindness, the sense is probably simply uneducated. Cases of color-blindness among women are very rare (1 in 25,000) and are not frequent among men. The eyes should be examined by a specialist in opthalmology if there is the slightest indication of nerve irritation, and the superficial examination, such as is indicated here, shows the slightest error of refraction or muscular insufficiency.†

Tests of the hearing may be made, and any dullness or difference in the auditory sense of the two ears should lead to an examination with the otoscope. The channel may be partially or completely occluded with wax or the debris from a previous inflammation or an exostosis of the wall of the meatus. If the opening is normal, the tympanum, or drum, will be seen at a depth of about two centimeters as a smooth, shining, semi-transparent membrane of slightly pinkish-gray color. In cases of inflammation the drum becomes decidedly pink. Slightly below and in front of the center is a white spot as though some white body

* See page 61 for directions for testing special senses.

† See the New York *Medical Journal* for January 7 and 14, 1888, and the same journal February 27 and March 13, 1886, containing articles by A. L. Ranney, M.D., on The Treatment of Functional Nervous Diseases by the Relief of Eye-Strain, etc. Also the Belgian Prize Essay, by Dr. Stevens, of New York, and the Report of the Stevens Commission, published in *The Neurological Journal*, 1889.

pressed the drum slightly forward at that point. This is the end of the bone, the malleus, that conveys the vibrations back to the internal ear. In most cases a gray streak can be seen extending upward and forward, which is the body of the bone. Sometimes the drum will appear bulging and convex, from the pressure of serum within, and the vibrations of the drum are prevented, with resulting deafness. Again the drum may appear cupped or concave from the stoppage of the eustachian tube and the subsequent absorption of air in the middle ear, so that the drum is pushed in by the atmospheric pressure. This is by far the more common condition and only impairment of hearing results until the case is of long standing, when complete deafness may ensue. Openings in the drum are of frequent occurrence as the result of inflammatory exudation bursting through from the inside, or traumatic puncture that has been uncared for. A puncture may not impair the hearing to any serious extent. Suppuration of the ear in any part should be the subject of surgical treatment at once, without regard to the whims or prejudices of the person possessing an otorrhœa. The discharge is often looked upon as a necessary affliction, and relief from other woes, but in reality it is a source of debility and impairment of health to the person himself, and a nuisance to others. Cases of impaction require treatment, and the same may be said of the convex drum. The concave drum may be due to catarrh, and if so, that should be treated.

In this connection it may be well to speak of nasal catarrh and its influence on health. The disease may be considered as a condition of mal-nutrition of the part affected, due to irritation of the trophic nerves. It may appear as an inflammation of the upper air passages with an increased secretion of mucous fluid; or there may be atrophy of the mucous surfaces and of the harder tissues beneath; or there may be extensive ulceration, and decomposition of secretions.

The first form is due to the action of irritants on a super-

sensitive membrane. The condition can be produced almost instantaneously by the inhalation into the nasal openings of snuff from pulverized tobacco, acrid fumes, dust, etc.; but the hyperaemia is temporary if the irritation is not repeated. The changes of the climate and passing from a warm to a cold atmosphere suddenly do not give the system time for the nice adjustment to environment that enables man to live in every climate where food can be found. The result is a continued irritation of the mucous surfaces of the air passages and a resulting inflammation with thickening of the superficial tissues until the normal nutrition of the part is lost, and disease becomes seated. This swelling may close the openings of the eustachian tubes, and impaired hearing is the result. Treatment is usually successful, and hence the importance of examining the nasal chambers if the history discloses any suspicion of defect in this locality. The other forms of catarrh are often quite as distressing without as favorable a prognosis, but relief will not be sought in vain.

The sense of smell in the atrophic and erosive forms of catarrh is often entirely lost, and in all cases is deranged. This sense may be tested by inhaling odors that are bland and unconnected with articles of food as musk, attar of roses, etc.

The olfactory nerve is perhaps more intimately connected with the brain tissue than any other, being apparently a prolongation of the brain through the cribriform plate to the nasal walls. As many cases of headache are due to a bad condition of the surfaces where this nerve is spread out we should examine such cases for ulcerations, tumors, malformations and displacements that may cause occlusion or pressure.

The sense of taste is closely allied with that of smell but is not so important an indication of the condition of the organs with which it is connected. It is a sense with great capacity for education, as it was the boast of Roman epicures that they could tell by the taste of a fish whether

it was caught above the Bridge or below. A taste may be acquired for the most nauseating substances. Children have been known to cry for cod-liver oil. But while the sense of taste is not important in its relation to health, the condition of the mouth may well occupy our attention in discovering those facts in a man's condition that make for health or debility. A clean tongue indicates good digestion ; while a coating indicates some abnormal condition of the stomach, or liver, or pharynx. A cracked tongue means dyspepsia. The tonsils should not protrude beyond the pillars of the fauces ; the general surface of the pharynx should be smooth and of light pink color ; the teeth should be sound or filled ; the vocal cords should be a light, pinkish yellow ; and the tracheal rings below look like white bands, between which pink tissue can be faintly discerned.

The temperature should be taken with the bulb of the thermometer placed under the subject's tongue for five minutes. This should be a record of 98.4° F. without a variation of half a degree. If the temperature is below normal note carefully the general conditions and repeat the test at some future time. About one or two per cent. of cases have a subnormal temperature. The instrument should be carefully washed in an antiseptic fluid after using and it is well to have a cup of saturated solution of boracic acid into which the mouth-piece of spirometers, etc., can be placed after taking records with them.

The tests of urine for albumen and sugar should be practiced until the examiner is sure of his ability. The simple methods now prepared by leading manufacturing chemists and druggists leave little except skillful manipulation to the examiner. The record should be repeated if any abnormality is found and the subject placed under the advice of a physician.

The director of a gymnasium should *always* recommend some other physician to cases needing medical care.

The following directions are given for testing the re-

fractive power of the eye and its color sense and also for determining the auditory power:

Procure of any optician two pairs of spectacles, one with convex glasses, No. +.75 Dioptric (equal to No. +.48 in the old or English system), and the other with concave glasses, No. +.75 Dioptric. Also obtain a copy of Monoyer's test letters (a card of Dr. Dennett's modification of Monoyer's test type may be procured of Meyrowitz Bros., opticians, 297 Fourth Ave., New York City), to be hung up at 5 meters distance, and a copy of Green's astigmatic lines, in the form of a clock face, to be hung up at the same distance.

Test:—Seat the subject at a distance of five meters from the test cards, which should be hung in a good light. Examine each eye separately, keeping the other covered by a card held in front of, but not touching it. Never press the fingers against the closed lid.

There are ten lines of letters on the test card, numbered from .1, .2, .3, etc., up to ten 10ths or 1. If now the subject can read the top line, the smallest letters on the card, with the right eye (R.E.) alone, his vision (V.) is recorded as ten 10ths or 1. (V.R.E.=1). If he sees nothing clearly above the fifth line from the bottom, but can read that correctly, then V.R.E.=.5. If he cannot read any of the lines, then V.R.E.=.0. (*i. e.*, less than one-10th). Whatever the vision without glasses may prove to be, *always next* put on the *convex* spectacles and again cover the other eye. If now he can still with the right eye see as well or better than with no glasses at all, and can read the same line as before, he is Hypermetropic (H.) in that eye. For example, if without glasses it was found that V.R.E.=.5, and now after adding the convex glass his V. is improved to .8, the record would be V.R.E.=.5, + H.=.8. But if the vision is neither improved nor made worse by the convex glass, the record will be thus: V.R.E.=.5, + H.=.5. If the convex glass can be used at all without decreasing the vision, no further testing with this card is needed; the subject is hypermetropic in that eye. If it is found that the vision of the right eye equals 1. without glasses, and then the addition of the convex glasses blurs the letters, the eye is Emmetropic, that is, the vision is normal (V.R.E.=1.).

If, however, the vision without glasses is less than 1., for instance only .3, and the convex glasses make even that line more indistinct, then put on the *concave* glasses. If now the vision is improved so that a higher line can be read, for instance the eighth from the bottom, the eye is Myopic, or "near sighted," and the record will be V.R.E.=.3, + My.=.8. Or again, if the vision without glasses in the left eye is found to be .7 and then with the concave glass the top line can be read, the record will stand thus: V.R.E.=.7, + My.=1. After testing each eye separately, place the record of one above the other, for example thus:

$$\left\{\begin{array}{l}\text{V.R.E.}=1.\\ \text{V.L.E.}=.6,+\text{My.}=.9.\end{array}\right.$$

This completes the testing for simple hypermetropia, myopia and emmetropia.

After testing the eyes as above, if the vision has not yet been made perfect in either, leave on the proper correcting glass, the convex if there is hypermetropia, or the concave if there is myopia, or use no glass if there is neither; then direct the subject's attention with that eye alone, the other being covered, to the card of radiating black lines. If he sees one or more of the lines running in any direction clearer or blacker than those at right angles to them, he is shown to be astigmatic. Either the perpendicular or the horizontal lines usually appear the blacker to the astigmatic person. If the previous record was V.R.E.= .7 and this defect is found, then it will be V.R.E.=.7,+As. Or if before it read: V.L.E.=.3,+My.=.6, and astigmatism is found, it will read, V.L.E.=.3,+My.=.6,+As. Astigmatism may exist either alone or in combination with My. or H. If alone we might have a record thus: V.R.E.=.6,+As.; V.L.E.=.4,+As., or if with hypermetropia thus: V.R.E.=.7,+H.=.7,+As.; V.L.E.=.6,+H.=.8,+As.

To recapitulate, in brief: if it is found that V.R.E.=1, then the R.E. is Emmetropic or Hypermetropic. If emmetropic, the convex glass will markedly impair the vision; if hypermetropic it will not. If the V.R.E.=.9 or less, then the R.E. is either hypermetropic, myopic, astigmatic or amblyopic.

1*st.* If it is H. the convex glass will not greatly impair the vision.

2*nd.* If it is My. the concave glass will improve V.

3*rd.* If it is As. one of the radiating lines is blackest.

4*th.* If neither of these defects exists and the V. is less than .7 then Amblyopia or partial blindness may be recorded. It may read thus: V.L.E.=.6,+Am.

Caution.—Always try the *convex* glass. *Never* try the *concave* unless the convex glass blurs the vision.

In the following cases the subject should be recommended to consult an oculist concerning the advisability of wearing glasses: If the vision without any glasses is less than .4 in either or both eyes; if he complains of weak, watery or painful eyes, especially in reading, and any degree of hypermetropia or astigmatism is found to exist.

Directions for Testing the Color Sense.

A reliable set of test worsteds of different colors may be procured for $1.25 of N. D. Whitney, 129 Tremont street, Boston. Among these will be found three large test skeins colored light green, purple (pink or rose), and bright red. To make the examination, spread all the worsteds out on a white cloth placed upon a table. First lay the *green*

test skein a little to one side of the others, and then tell the subject to throw out of the pile and lay along side of the test skein all the lighter and darker shades of that color, or all the skeins containing a shade of that color in any degree. Avoid naming the color "green" to him. If he throws out only shades of green or light blues his color sense is normal (C.S.N.) and the test is completed. But if in addition he throws out light grays, or any other shade of gray, or light yellows, salmons, or pinks, he is color-blind. If he handles or fumbles over those shades a good deal and hesitates, as if in doubt about them, but yet does not throw them out, he probably has "feeble color sense" (C.S.F.). The examiner in these cases must use his judgment in making a certain amount of allowance for the stupidity of some persons in understanding what is wanted, especially in the young and uneducated.

If the subject is found to be color-blind, next lay down the purple or rose-colored test skein, in place of the green, in order to determine the nature of the defect. Now tell him to throw out all the different shades of that color. If he only throws out pinks and light reds and shades approaching these he is only partly color-blind. (P.C.B.) But if he throws out decidedly bluish purples, blues, violets, greens, or grays, he is completely color-blind. (C.C.B.) Completely red blind if he throws out the blues, violets, etc., or green blind if the grays or greens.

No further testing is needed, but as a matter of curiosity and to prove the result, the red test skein may next be tried in the same way. If he matches with it browns or greens and grays he is completely color-blind. Dark brown or green if red blind, and light brown or green if green blind.

It is not important to record whether the complete color-blindness is red or green blindness. The following classes may be recorded:— Color sense normal=C.S.N.; Color sense feeble=C.S.F.; Partial color-blindness=P.C.B.; Complete color-blindness=C.C.B.

Color-blind individuals should be warned against engaging in any occupation where this defect would prove dangerous or inconvenient.

Directions for Testing the Auditory Sense.

Use an ordinary watch and a tuning fork, letter A. or C., as tests. Seat the subject with his right side toward you, and then while the room is perfectly quiet, see how far off he can hear the watch tick. Having previously learned by a few experiments what is the furthest distance at which the tick can be heard by normal ears, make that number of inches the denominator of a fraction, and the hearing distance of each person examined thereafter the numerator. Having found the normal distance (=H.D.) to be, for instance, about sixty inches, and that of the subject now examined to be, say forty inches, his record for the right ear would then be: H.D.R.E.=$\frac{40}{60}$. If it had been $\frac{60}{60}$ or 1, the

ear would be normal. $\frac{80}{60}$ would show an abnormally acute sense of hearing. If the watch could only be heard while in *contact* with his ear, it would be recorded: H.D.R.E.$=\frac{c}{60}$. If not heard at all, then H.D.R.E.$=\frac{0}{60}$. Next test the left ear in the same way. Voice sounds in talking will often be easily heard by persons quite deaf to the watch tick, so that the latter is not always a reliable practical test.

Suppose we have found H.D.R.E.$=\frac{40}{60}$, H.D.L.E.$=1$, this implies some deafness in the right ear, and the tuning fork will now help us to decide whether the cause lies in some defect of the auditory nerve or internal ear, or in the external or middle ear or Eustachian tube. Strike the fork against some solid substance, and then place the end of the handle against or between the subject's front teeth. If both ears are normal he will probably seem to hear the ringing of the fork equally well in both ears. But if there is a defect in one ear he will either seem to hear it louder or more feebly in the affected ear. If, as in the case we are examining, the fork is heard best in the deaf ear, this tells us that the deafness is due to some defect in the more external parts of the organ, and it can probably be corrected by appropriate treatment. But if it is heard best in the good ear, it goes to prove that the defect in the other ear is more deeply seated and cannot probably be greatly benefited by treatment. This effect of the tuning fork is contrary to what would ordinarily be expected, and it is often a matter of surprise to a deaf person to find that he hears with his teeth apparently better on the deaf side.

We may now add to our record in this case: T.F. best R.E. If it had been heard equally well in both ears we would record: T.F.=N. (or normal). Where the defect in hearing is at all marked a specialist in ear diseases should be consulted.

Our record in a normal case might be thus: H.D.R.E.$=1$, H.D.L.E.$=1$., T.F.=N.; or in an abnormal case it might be thus: H.D.R.E.$=1$., H.D.L.E.$=\frac{0}{60}$, T.F. best in R.E. This would imply that the subject was so deaf in the left ear as not to be able to hear the watch tick at all, and the fork held between the teeth could be heard best in the good ear, consequently his trouble is probably seated in the deeper structures of the ear, or in the nerve itself, and treatment would not be expected to help him greatly. The tuning fork need not be tried unless the watch tick shows some defect in hearing.

CHAPTER V.

EXAMINATION BY INSPECTION AND PALPATION.

After the measurements of a person have been taken, the work of examination and physical diagnosis should begin. The measurement is mechanical and could be done correctly by any person, after a little practice ; but a physical examination requires the highest product of scientific training backed by sound judgment in order to discover the true condition of organs and determine the real cause of the disordered function or disturbed growth. It may require only a mechanical eye to discover a curved spine, but it must be the mechanical eye, backed by a thorough knowledge of physiology and anatomy, that can discern the fact and the cause.

The suggestion of remedial agents again pre-supposes a knowledge of therapeutics, and this field is as broad as surgery, which rests on a knowledge of the same sciences. The therapeutic side of gymnastics has been more thoroughly worked out by the Swedes, who, following in the footsteps of Ling, have studied exercise, both active and passive, from a medical standpoint, and have developed a system of gymnastics that has been approved and applied by medical men all over the civilized world. Massage as one part of this system is applied in a rudimentary way to a great variety of cases in this country, but with the best success only by practitioners of foreign education. There is a call then for the most extensive preparation in this field of work, and in no line of medical practice is there as broad a field for original scientific research as in this, the prescription of exercise. The following technique is recommended to all those who are making a physical examination :

I.—Inspection should be made with the subject entirely nude and standing easily. If a military attitude is assumed, try to get relaxation into the ordinary positions. This can often be done by calling the attention to some trivial matter, as any peculiarity of the hands or feet, or by having the subject step forward or backward a few steps, when he will forget his strained position. From the front notice (1) the general coutour or relative breadth, (2) the position of the head, (3) the position of the shoulders and arms, (4) the curves of the trunk, (5) the muscular condition of chest, abdomen, and legs, (6) any malformation, such as tumors, cicatrices, etc.

From the side notice (7) the antero-posterior or normal spinal curves, (8) the depth and mobility of the chest and abdomen, (9) the position of the shoulders, (10) the relation of the hips to the loins, (11) the relation of the neck to the trunk, (12) the general attitude of the subject.

From the rear notice (13) any lateral or spiral curvature of the spine and prominence of spinous processes, (14) the condition of the shoulder and scapulae, (15) the waist curves, (16) any tipping of the iliac crests due to one short leg or imperfect bone development, (17) the outline and position of the legs and indications of varicose veins and cyanosis, (18) the muscular condition, (19) the condition of the skin, and (20) any tumor or malformation.

Of course the examiner will not look up each one of these points in regular order, but he should study each one and after an examination go over the list and see how many points there are on which he has no clear, definite knowledge, and then try on the next case to make the list smaller until he will take in everything at a glance, as it were. There are many other matters to which attention might be called, but they are mostly amplifications of the above list.

We include in (1) the breadth of head as giving some idea of the temperament and vitality of the subject. A broad head at the base is believed to indicate a greater vitality

than is found when the head is long and "top-heavy." There is greater power of resisting disease and less liability to nervous irritability of a pathological character. A thin, weak neck means a bad curve forward at the cervical portion of the spine, and a consequent flat chest in a large majority of the cases. The voice will be uncertain and the throat suffer from catarrhal diseases on the slightest provocation.

Narrow shoulders mean compression of the upper part of the thorax, and less activity of respiration in the apices of the lungs. This, with a history of tuberculosis is unfortunate, because tubercular degeneration usually begins at the apex of the lungs and an inactive part is an unhealthy part. This fact has led Dr. T. J. Mays to claim in an article published in the "Therapeutic Gazette," May, 1887,* that the wearing of corsets by ladies may be a protection against phthisis, because by compressing the abdomen and lower part of the thorax costal breathing with a freer use of the apex of the lung was necessitated and a consequent immunity from tubercular degeneration was the result. The fallacy of this theory has been repeatedly shown but by no one so completely demonstrated as by Dr. J. H. Kellogg of Battle Creek, Mich., whose investigations regarding normal respiration are complete and original.†

The breadth of chest is one of the three factors in making up the "Vital Capacity," and its relation to the breadth of waist and hips will give a better idea of the natural strength than the size of the biceps. Any depression of the ribs or sternum should be noted. I have seen a case of severe hepatic disturbance that had resisted medical treatment for many months, recover more than ordinary health under a series of exercises that tended to lift two depressed ribs over the liver into a more arched and natural position.

Notice any elevation of the chest wall in the cardiac region, and any transverse depression at about the sixth rib.

* See "Med. News," Nov. 27, 1886.

† Transactions of the Mich. State Med. Society, 1888.

The elevation may be due to enlargement of the heart or pericardiac effusion. The depression is due to faulty habits of sitting—the person sliding forward in his chair and sitting on the sacrum, instead of on the buttocks. This depression causes a pressure on the heart and interferes with the circulation and also causes indigestion quicker than plum pudding by restraining the muscular activity of the stomach wich is very marked during digestion.

Under (2) we should note any position of the head that might denote a shortness of the sternomastoid muscles. A shortness on one side tends to tip the head toward that side and turn the face to the other ; if both muscles are short they tend to draw the neck forward and tip the face up. A narrow thin neck indicates, generally, poor respiratory power and a catarrhal throat with laryngeal sensitiveness, especially if in (7) we find the cervical curve very deep, or the neck slanting forward because of poor support from weak muscles. A strong neck is very desirable. It not only holds important organs in place and insures good circulation in the brain by making the channels direct but it gives an aggressive carriage, and indicates determination and pluck. In (3) we observe the slope of the shoulders and the relation of the acromions to the sternum. If a line be drawn from the acromion tip to the base of the neck, and continued to the spine, it will make an angle with the line of the spine which should approximate to 80°. If the muscles that support the shoulder be weak, they permit the acromial tips to sink, making the angle less, while if these muscles be over-developed they draw the tips up and give a stiff hunched appearance that is ungraceful. If the muscles in front be better developed than those behind, the shoulder will be drawn forward and down, giving an apparently flat chest with sloping shoulders, which is a mark of slack habits and lack of all exercise of a vigorous character. When you get hold of such cases you will feel like taking them by the shoulders and, after giving them a violent shaking, telling them to "brace up." The effect of

this posture on respiration will be evident to every person with a knowledge of the elements of anatomy. The person has no energy or "sand" because his blood is not properly aërated. The arms hang forward, giving the feeble, helpless attitude assigned by caricaturists to the innocent "dude."

By (4) we mean the outline curves of the waist, which show something of the strength of trunk that may be expected, and the outlines of muscles that give the beautiful curves seen on the athlete. These lines may not be clearly cut in some cases of well developed muscles on account of the adipose tissues immediately under the skin. This last point will help us in estimating muscular condition (5) which can not be judged altogether by size.

It is well to remember that, in (6), we must not only decide as to the character of the malformation but know what the prognosis or probable development will be—what interference with exercise will be caused and what exercises are contra-indicated—what will be the influence on health—what does it indicate as to the physical stamina or constitutional strength. For instance, varicose veins may never have given any trouble and may never have been noticed. How long could this condition exist unnoticed and what may be expected from it now? What exercises should be avoided, etc., etc.? In surgery the word tumor means any abnormal enlargement of an organ or tissue.

Perhaps the most frequent form of tumor that will be found is due to rupture or hernia. A hernia is a tumor caused by the passage of a portion of an organ through the bony muscular or tendinous wall that normally confines it. It may be produced suddenly by a severe strain or bruise, or it may be the result of a gradual distension of one of the natural openings of the wall. Cases of intestinal hernia are frequently found, and among young men will affect two or three per cent. of all, while among those past middle life it will affect as high as six per cent. Among females it is much less frequent. This is due to the less

patulous inguinal openings in the female and to less exposure in the daily avocations of life. Abdominal hernias are classed as inguinal, femoral, umbilical, diaphragmatic, etc., according to the place where the viscus forces its way from its natural support.

An inguinal hernia may appear at the external inguinal ring as a round tumor of greater or less extent and is then called "direct," while if it appears first at the internal ring and passes down the canal it is called "oblique." The latter form is much more frequent and tends to develop rapidly downward, giving the tumor an elongated form with higher origin than the direct.

In femoral or crural hernia the intestine passes down through the crural ring under Pouparts' ligament where it causes a protrusion of the anterior wall in a round tumor that lies in the groin just below the fold at the saphenous opening. It is situated farther externally from the median line than the direct inguinal and if large will have its axis in a horizontal rather than a perpendicular direction.

These three forms of tumor must be readily differentiated from cystic tumors, varices, glandular enlargements, etc.

Cysts have a well-marked fluctuation. Varices have fixed relations to the venous trunks and subside on the subject assuming a horizontal position and fill again on rising if the inguinal rings are supported. Glandular swellings are due to some attendant local irritation and are painful and unyielding to pressure.

The antero-posterior curves of the spine (7) are a concavity in the cervical and lumbar regions and a convexity in the dorsal and pelvic. These curves may all be exaggerated by disease or occupation or muscular development. Any increase in the curves must shorten the total height. Any weakness of muscles at the back of the neck will permit the head to hang forward, thus increasing the dorsal convexity, producing round shoulders, or kyphosis. An over-development of the lumbar muscles as compared with those of the abdomen will increase the lumbar concavity, causing lordosis. The strong back is the straight back.

The gymnastic treatment of lordosis, or abnormal anterior curvature, is the only satisfactory one where there is no caries or breaking down of bone. The same is true of kyphosis, of which Dr. Stedman writes for The Reference Handbook: "A cure of adolescent kyphosis, when of slight degree, may be obtained by exercise alone, without mechanical support; but it will be found advantageous to aid the patient in maintaining an erect posture by suitable apparatus.—The treatment by exercises in this form of kyphosis should never be omitted, since the fault lies chiefly in a want of tonicity of the muscular and ligamentous tissues."

If there is exaggerated curve at any part of the spine, there will be more or less compensatory curve in the opposite direction at other parts; and, in prescribing exercise, great care must be used in deciding which is the primary and which the compensatory curve, for an error would make matters worse from the development of parts already strong, and the neglect of parts that are weak.

In observing the depth of chest and abdomen, (8) and the movement of each under respiration we have a clue to the activity of the person. If the chest is deep at the sixth rib, but thin at the second, the sternum will usually be found unsupported by the muscles of the neck; those behind being weak and letting the spine slope forward at the upper part so that the sterno-mastoid and the scaleni muscles can not raise the chest. This throws all the work of respiration on the diaphragm, and the person is unfitted for any athletic exercise, and would have a cramp in his side if he were to run an eighth of a mile. It is said that a round chest of equal girth with a flat one will not show as great a lung capacity on the spirometer, but my experience does not corroborate the statement.

If the abdomen protrudes, or sags, so that the intestines seem to be held just above the pubic arch, especially if there be a history of hernia, or excessive corpulence, or indigestion, the matter is of such import as to call for thorough instruction and earnest advice. Much discomfort,

ill-health, and physical suffering will be saved such cases, if the abdominal muscles be developed by persistent exercise—the abdominal cavity contains quite as important organs of health as the thorax, and the competent instructor will not spend all his time and talk on the chest.

In (9), (10), (11), (12), we have some of the points that go to make up the carriage or general appearance of the subject, and they constitute the difference in physique between a West Point cadet and a slouching loafer.

Our rear view of the subject will disclose any lateral curvatures (13) of the spine, or scoliosis, and we should not only see any deformity of this character but should be able to judge of its nature, and determine its causation. The curve may be simple and confined to one part of the spine, or it may be multiple. In the latter case one of the curves is usually the primary lesion, and the others compensatory. The reason for the compensatory curve is found in the natural effort to maintain an erect carriage. If there be a slight curvature to the left in the lumbar region, it would tend to tip the shoulders to the right but the natural effort to straighten the spine has most success where the muscle is stronger and not at the point of greatest weakness, toward which the convexity lies. The result is the bending of the upper part into such a position that the weight is in equilibrium, and the shoulders fairly level. This effort to bend a higher portion of the spine to produce a balance of weight usually is the cause of a slighter curve higher up in the cervical portion, that restores the head to the erect position. This gives a curve to the left, in lumbar region, another higher up to the right, in dorsal region, and another still higher to the left in the cervical portion of the spine. If this explanation is correct it is plain that the predisposing cause of scoliosis must be due, in a large majority of the cases, to the weakness or uneven development of the muscles and ligaments that support the spine. If the muscular strength and activity of one side be greatly in excess of that of the other, the spine must of necessity be drawn to that side which will throw the convexity toward the weak-

ness. If this principle obtains in all the anatomical relations —and its influence can not be denied—no better argument could be used in favor of training for bilateral symmetry.

The fact that girls are affected by spinal curvature more often than boys (the proportion being 4 to 1) would seem to indicate a need of more robust exercise out of doors or in gymnasiums that shall give a development of the erector-spinae mass and all the muscles above the hips that shall compare favorably with that of boys. The influence of corsets and stays has been repeatedly shown to be the cause of great muscular debility in the parts constricted, and all medical authorities assign a large part of responsibility for curvatures to their use. The lumbar muscles of the female have a comparatively larger field of origin at the pelvis and should be correspondingly strong, but under the differentiation of civilization and the corset, the female waist has degenerated into a backache.

Pressure on a muscle tends to drive the blood out, and if it be continuous, the circulation is impaired. This condition means bad nutrition of the muscle, and that leads to imperfect development or to actual atrophy. Is it any wonder then that a physician hears from his female clients one long complaint of weak backs, back-aches and general debility !

The remedial exercises for curvatures need only be suggested here, as the only treatment, is forcible straightening and proper exercises. The care should be exercised on the weakest spot, which, in some way, " must stand the strain." Suspension, as on the rings and bars, and the direct exercise, either active or passive, of the degenerate muscle, is the general plan of treatment.

The prominence of the spinous processes are of diagnostic value in locating weak spots. If the interspinous ligaments have been strained and stretched by lack of muscular support or bad habits of posture, as sitting back on the hips, and letting the weight of the trunk press the lumbar vertebræ back, or a pernicious habit of letting the head hang forward, the saw-toothed appearance of the spine, as

the subject bends well over, will disclose the fact. Notice the alignment of these processes as the subject is bent over, and straightens up. A failure of one or two, here and there, to stand in the line, is not an indication of disease, but is due to a slight bend in the process, as will be seen on examining almost any skeleton. The spinal curvature will be indicated by a number of them assuming a general curved outline.

The mobility of the scapulæ (14) varies greatly in different people. A more beautiful contour exists when the trapezius and rhomboïdei are strong and short holding the scapulae down and well back to the spine, but the range of arm movement is not so great. A good development of these muscles is very desirable as they prevent the shoulders from rolling forward and flattening the chest.

In (15) notice the size of the lumbar muscles, with the subject bent over.

It should be borne in mind that a shortness of one (16) leg is comparatively frequent, and this deficiency causes the pelvis to tip with resulting spinal curvature. Distocia, or deformity of the pelvis may have the same effect.

The bone of the legs (17) can not be greatly changed by exercise, but something can be done in early life to relieve one of the burden of bow legs or knock-knees. Therefore, in the examination of children, do not overlook this point; nor needlessly turn the attention of the subject to it when there is no relief, but occupy his mind with matters that can be improved and modified. In observing the legs, notice any cyanosis about the ankles, and varicose condition of the veins, especially of the lower leg. In some persons the skin is firm and seems to fit the underlying tissues very closely, thus giving support to the venous walls; while in other cases the skin is relaxed and thin, furnishing poor support to the superficial vessels. If we recall the fact that the hydrostatic pressure alone in a person of ordinary height, while standing, would be a trifle over two lbs. in the vessels of the foot, and that the friction of the current along the vessel wall, the impedi-

ment from constriction of clothing and speed of the current, all add to this pressure we can readily see why certain classes of people are specially liable to dilation of the veins, and suffer accordingly. Persons obliged to stand much of the time without great change of position (as clerks, book-keepers, bench mechanics, etc.), and very fat people, who stand a considerable part of the time, are most often affected. The pressure on the external iliac vein in corpulent people is a predisposing cause, as it prevents the free return of the blood into the trunk ; and the same may be said of garters, tight clothing on the thighs, or elastic thigh bands, tight belts around the waist, corsets, and any garment or device that prevents normal respiration. (See illustrations, Chap. IX.) The proper advice in these cases is clear. Restriction should be placed on all exercises like jumping where the feet strike the ground hard ; running on pavement, floors, etc.; bicycle riding, because of the pressure of the saddle on the femoral and saphenous veins ; violent exercises, like foot ball, etc., etc. Light exercise should be encouraged, for, the better the tone of the tissues, the less giving way will there be to pressure. Exercise of the skin to keep it healthy and firm —such as massage and cold water baths, to stimulate the contraction of the tissues—will be of assistance. In this condition, "forewarned is forearmed." Cyanosis is a varicose condition of capillary veins and indicates poor circulation. In cyanosis about the trunk search carefully for some heart lesion.

The condition of the skin (19) will signify much to the careful examiner. Not that every subject with acne should be set down as dyspeptic, but in an almost intuitive way the careful observer will learn to diagnose many internal ailments and judge of vices that might otherwise be unknown. There is something that can not be described in the healthy, firm, velvety skin of an athlete. It must not only be seen, but felt, in order to be appreciated. It is better to be rolled in the dust by a hearty, healthy wrestler than to shake the flabby, moist hand that is placed in

yours by some advocate of moral suasion and intellectual top-heaviness. The skin, like the eye, is the mirror of the bodily health, if we only know how to see the image clearly. Its firmness, its elasticity, its smoothness, its moisture, its odor, its color, its warmth, all are full of meaning. Physicians often read the complaint in the countenance of the patient, before his mouth has uttered it. We have in observation not only the facial countenance but the expression of the whole body. How much, then, should we rightly judge of the inner man! The delicate tint seen on the skin of the woman who has exercised in the open air, until every tissue proclaims her the type of health, is as superior to the rusty covering of the dyspeptic house plant, as that is superior to the hide of a pachyderm. Local diseases may deform the skin, but the indications of general health will be found, if it exists.

The following table will present in compact form some of the more prominent points observed by inspection:

GENERAL ASPECT.

- (1) Form.
  - Front View.
    - Aspect of chest.
      - Flat.
      - Round.
      - Bilateral asymmetry.
      - Sternum depressed.
      - Pectoral muscles.
    - " " waist.
      - Breadth.
      - Muscles.
    - " " legs.
      - Bow-legs.
      - Knock-knees.
      - Muscles.
    - " " neck.
      - Sterno-mastoid.
      - Lateral muscles.
  - Side View.
    - Poise of head.
    - " " thorax.
    - " " loins and belly.
    - " " hips.
  - Rear View.
    - Breadth.
      - Neck.
      - Shoulders.
      - Waist.
      - Hips.
    - Height of acromions.
    - Line of spinous processes.
    - Scapulae.
    - Pelvic crests.

- (2) Nutrition.
  - Unduly thin.
    - Sickly aspect.
    - Healthy " } Atrophy.
  - " fat.
    - Evenly distributed and firm.
    - Unevenly " and soft.
    - Fatty degeneration.
- (3) The Skin.
  - Eruptions.
    - Acne, furuncles, etc.
    - Eczema.
    - Psoriasis.
    - Tinea.
      - Circinatus.
      - Versicolor.
      - Tricophytosis cruris.
    - Ulcerations.
    - Erysipelas.
  - Cicatrices.
    - Traumatisms.
      - Bruises.
      - Burns.
      - Cuts.
      - Lacerations.
    - Carbuncles, variola, etc.
    - Abscesses.
      - Free.
      - Bone.
  - Tumors.
    - Sebaceous.
      - Comedones.
      - Seborrhœa.
      - Sebaceous cysts.
    - Hypertrophy.
      - Ichthyosis.
      - Goitre.
      - Condylomata, callus, etc.
    - Malformation.
      - Chicken breast.
      - Retained testis.
      - Funnel chest, etc.
    - Cysts.
      - Varicocele.
      - Hydrocele.
      - Abscess.
  - Discolorations.
    - Lentigo.
    - Chloasma.
    - Jaundice.
    - Erythema.
    - Purpura.
    - Cyanosis.
    - Bruises.

CHAPTER VI.

PALPATION.

The use of the sense of touch, or palpation, is of great importance in locating tumors and determining chest movements, viz: frequency of respiration, vocal fremitus, ronchi, frictions, etc. By the eye you can only imperfectly judge of size and consistency. An arm may be large, but, if soft and flabby, it does not indicate health or strength; while if it meets our hand with a proper resistance—not too hard nor too soft—we know that it is capable of good things, be it large or small. Palpation enables us to say how much fatty tissue underlies the skin, and how firm the muscle is under the fat. It is a mistake to set every person with abundant adipose tissue in the list of "muscles undeveloped." Nor is fat a substance of no worth to the physical economy and to be avoided. In certain quantities it is of the greatest advantage to health, and is an indication of high nutrition. It is so much physiological capital stored up, and is so located as to prevent loss of heat by radiation, especially over the more sensitive organs, and therefore saves the energy that would be lost in heat. This is nature's way of protecting her children from the increased severities of the season; for, as autumn brings presages of winter by her cooler nights, every animal, in health, grows fat, and those that are exposed to continued low temperatures, like whales, seals, bears, etc., lay up enormous stores of it underneath the skin, where it will do the most good, and over the abdominal organs and heart. If the supply of food is cut off, the fat is consumed to provide vital force for long periods of time. The same is true of man, but to a less extent. As civilization has relieved

him of many of the exigencies of nature, it has modified his requirements, restricting them in some directions, and enlarging them in others. The modern civilized man needs less fat than the Esquimaux, because he has a milder climate and better facilities for heating his house, but he needs some fat to prevent the irritation of the nervous tissues from the adjustments of heat production that are so rapid in a well-balanced body, when we pass from a cold to a warm atmosphere, and the reverse. This strain is thrown on the involuntary or sympathetic nervous system, and this is the part that breaks down in the so-called "nervous prostration," or "neurasthenia," which is so common. Not that lack of fat stands in causative relation to this disease, but that one source of strain is found here. Such persons bear the cold badly and seek warmth; their treatment is warmth and nutrition. The argument, then, is that a fair amount of fat is conducive to health of the nervous system. The same may be said of all the other organs. The lean man has no extra physiological resource to fall back upon, if irregularities are forced upon him, either in the way of lessened food supply, or sleep, or greater demand on his energy, either physical or mental, and his comfort and health soon suffer.

By palpation we may also judge of the temperature and moisture of the skin, and thus estimate its activity in excretion. A healthy skin should be firm and velvety, even in texture and activity, slightly moist under ordinary circumstances but not wet, colored a delicate shade of pink, without being flushed or having dilated capillary vessels, as will be found common in the clavicular or scapular region. If the skin is hot and flushed, it indicates the presence of fever, or a local disturbance of circulation, due to deranged nerve activity. If the skin be dry, and tends to form scales, the superficial circulation is insufficient, and bad digestion is a common accompaniment. Free exercise, shower bathing, massage and friction will set things to rights if persistently employed, unless the skin

be affected by ichthyosis, which "is a congenital, chronic, hypertrophic disease," and hence will be but little benefitted. Profuse perspiration is found frequently, and seems injurious only in prolonging bronchial inflammations and general catarrhal conditions, by keeping the clothing damp a large part of the time. There is also an increased liability to Bright's disease from high concentration of urine and chilling of the surface on slight exposure.

Hyperidrosis will be favorably influenced by active exercise, as the circulatory system will at that time be depleted by the free sweating, and will give up less moisture in a state of rest. After exercise the damp clothes are removed, the sweat is washed off in the shower bath, and the skin is dried by proper massage, leaving slight liability to "colds." Local hyperidrosis may seriously impair the health by keeping the feet damp and cold and thus induce catarrhal, pneumonic, and rheumatic conditions. Medical advice is to be recommended in such cases, if hygienic precautions—such as cold baths, frequent change of clothing, sensible shoes with cloth tops, proper diet and regular exercise—do not avail. At times the under and inner surfaces of the toes and the outside margin of the foot from the little toe back to the instep will appear white and swollen in these cases. This condition closely resembles large blisters from scalds, but is only a water-soaked, "parboiled," state of the epidermal layer, like that seen on the hands of washer-women after they have been in hot soap-suds for a half hour. The advantage of a cloth-top shoe in these cases is apparent when we think of the comparative ease with which moisture passes through woolen fabrics as compared with difficulty of evaporation through leather.

A condition of anidrosis, or too scanty perspiration is frequent without evident impairment of health. The skin is apt to get very dry and harsh, especially in cold weather, and eczema of the hands result. In many of these cases there is no general sweating, even in extremely hot weather, and perspiration is not copious.

It may be well to explain that "perspiration" is the term applied to the insensible exudation from the sweat glands that is evaporated as fast as secreted, while "sweating" is the appreciable collection of this exudation in drops of greater or less abundance. (See Foster's Physiology).

In addition to what we learn of the integument and muscle by palpation, we detect by it certain movements that characterize health or disease. If we place the hands firmly on the walls of the chest, letting the fingers press the intercostal regions, there will be felt a movement of the chest on each inspiration and expiration, if respiration be normal. Any failure in expansion is noticed if there be interference with the chest action, from muscular or mechanical cause, that is unilateral. There should be bilateral symmetry of movement, but this may be hindered by muscular soreness from rheumatism, neuralgia, traumatism, etc.; paresis of a muscle, or group of muscles; intrapleural effusions; new growths; or by solidification of the lung or any considerable part of it. Malformations may also interfere with bilateral symmetry of movement.

If the subject be asked to repeat some word such as "ninety-nine," or to count aloud, one, two, three, while the hands are on the chest, as above described, a peculiar vibration will be felt, which is known as the "vocal fremitus." This thrill, or vibration, is much more prominent in persons with thin chest walls and low pitched voices, than where the wall is thickly padded with fat, and the voice in high key, on the same principle that the low bass strings of a piano, when struck, impart vibration to solid articles in the room in an appreciable degree; while the high notes have a less perceptible effect. The "vocal fremitus" is somewhat plainer on the right side, on account of the larger size of the right bronchial tube. A fremitus may be caused by other sources of vibration than the voice, as by a cough, by mucous rales, by pleuritic friction, and the splashing of liquid, when the chest contains liquid and air.

The "ronchial fremitus," due to mucous in the bronchial tubes, is frequently very marked in bronchitis, and felt by the subject himself; but the area is circumscribed in most cases. The friction fremitus of pleuritic inflammation is faint and local in character. In general, those diseases that produce solidification of the air cells of the lungs, without obstruction of the bronchial tubes, increase the vocal fremitus; while those that interpose more air, like emphysema, decrease it. Liquids diminish or check it altogether. The scapulæ interfere with the fremitus as does the liver, the latter not conveying the vibrations, and, if pressing firmly against it, preventing the chest wall from doing so below the margin of the lung.

Palpation is of great service in the diagnosis of tumors. The fingers are to be placed on one side of the swelling, and gentle but firm pressure made on the opposite side of it with the fingers of the other hand, by a quick movement of the wrist. If the contents of the tumor are liquid a bulging will be felt under the fingers, caused by the displacement of the fluid, that passes as a wave through the tumor, distending the sac at one part to accommodate the liquid depressed at another. This peculiar wavelike motion, called fluctuation, can be well studied by examination of a rubber water bag under varied thickness of covering, having the bag distended hard, and again with less water in it, but no air. In cases of ascites the wave impulse is readily felt across the abdominal cavity—a light tap with the end of the finger against the side being sufficient to start the wave. A close estimate of the amount of fluid can be formed in this way, as the wave simply continues through the liquid part, and is not propagated by the intestines or general tissues.

The apex beat of the heart may also be located by palpation in a large majority of cases. In many subjects the chest wall is thin, and the heart action strong, so that inspection can determine the apex impulse with tolerable precision; but if it fail to fall in an intercostal space, or

the chest wall be thick, or the heart-beat feeble, palpation must be used. In this connection it may be said, that for this purpose the ear may be the organ of tactile, as well as of auditory impressions.

The character of acute or chronic inflammatory action can often be determined by palpation, as in swellings about joints.

CHAPTER VII.

PERCUSSION AND AUSCULTATION.

The condition of the internal organs is determined in several ways. Among the most frequently employed, because most satisfactory in results, is by listening to the passive and active sounds so far as they can be secured to the ear. The passive sounds are obtained by percussion, or striking the surface over an organ, either with the tips of the fingers or a rubber mallet directly, or by laying a solid substance, or the finger, firmly against the surface, and striking this. The first method is called immediate percussion, and is seldom used, except for hard, bony surfaces. The second is called mediate percussion, and is applicable to all parts.

The sounds obtained by percussion vary in quality, intensity and pitch. The quality of the sound obtained over the various organs can only be rudely described, but practice will give skill in distinguishing it. The intensity will vary according to the surrounding medium, and the pitch will vary largely through change in the organs that produce the sound.

The region of the body most frequently examined by percussion is the thorax. The abdomen, especially in conditions of disease, is often examined by this method (in connection with palpation), but without the satisfactory accuracy that is to be secured over the chest, although it enables one to distinguish the outline of solid tumors of hepatic, splenic or intestinal origin and the area covered by cystic enlargements.

The method of employing percussion is generally with the fingers, although, if many examinations are made daily,

it is well to use a pleximeter and percussor (as shown in cut). It seems to the writer that the appreciation of vibrations by the finger is of considerable importance in assisting the ear, and, therefore, that digital percussion is better than instrumental. The act is easily performed by laying the fingers of one hand firmly over the part to be examined, and, with the tips of the first two or three fingers of the other hand, or the middle finger alone, striking against one of the fingers imposed on the part with a firm blow, accomplished by a wrist movement of flexion. The force of the blow may be varied to perceive the difference in resonance,

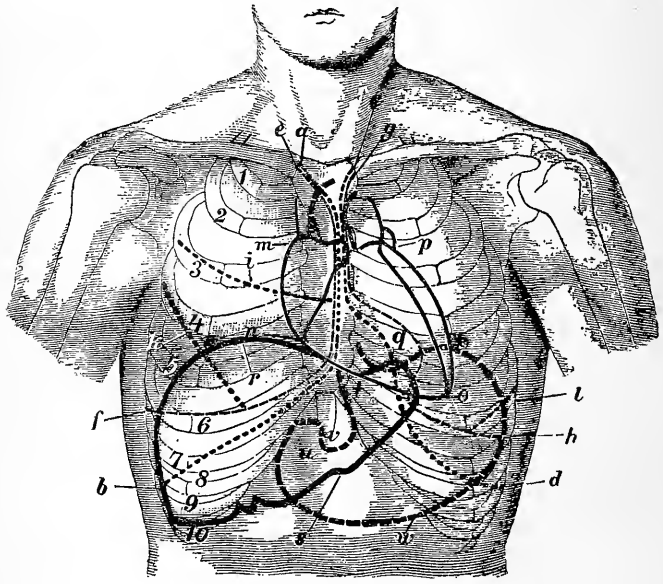


Fig. 19.

Showing the normal outlines and positions of the heart, lungs, liver, and stomach. The light dotted line shows the outline of the lung at inspiration b. d. and at expiration f. h., and also the lobar divisions at i. k. l. The heavy continuous line shows the outline of the liver. The light line shows the location and divisions of the heart. The heavy broken line indicates the outline of the stomach. Luschka.

quality, and pitch of the sound under the new conditions, as this may have an important bearing on our determination of the case. Forcible percussion sets in vibration deeper tissues, and, if their condition varies greatly from the superficial tissues, there will be a mixed quality to the sound that aids in identifying healthy activity, or disease, or abnormal position. For instance, if we begin at the right clavicle and percuss downward, until we reach the lower edge of the liver, we shall pass over lung tissue at first where the sound elicited under mild or forcible percussion is essentially the same; lower down we reach a part of the lung that contains the large bronchial tubes when the pitch is lower and resonance good, then still lower to a part that is backed by the upper convexity of the liver with only the solid diaphragm and lung between it and the chest wall. Here under mild percussion the resonance is unimpaired; but under a firmer stroke the resonance is found to lose its clearness and become duller, and this dullness increases as we percuss to the very edge of the lung, where the sound is flat. See Fig 20. The term "flat," as applied to percussion sounds, is such a quality of tone as is produced when an organ containing no free gaseous element is set in vibration by an impact. The word "dullness" is comparative only and denotes less resonance than should be expected under normal conditions.

In using the plexímeter, we press it firmly against the surface, and strike upon it with the rubber percussor. The resonance of the instrument is slightly confusing to the person who has been accustomed only to digital percussion, but practice soon enables us to eliminate this sound, as one does the sounds of mercantile life while listening to a voice in the telephone. Practice alone will give skill in the determination of normal or abnormal sounds. It may be remembered that for any individual the resonance of the chest is fairly constant in health, but that of the abdomen varies continually; again, the resonance of the abdomen

is always tympanitic or flat, while that of the healthy chest is neither. In making a physical examination, percussion of the abdomen is useless, unless there be a history of abdominal disorder, or inspection and palpation indicate something abnormal.

For convenience in describing any location on the anterior aspect of the trunk there has been a long-continued custom of dividing the body into a right and left half by a median perpendicular line and then designating the portion on either side above the clavicle as the supraclavicular region, right or left. The portion below the clavicle as far down as the third rib is called the infraclavicular region and the part covered by the clavicle is called the subclavian region. The mammary region extends from the third rib to the sixth. Below the sixth rib is the inframammary region, extending to the margins of the ribs. The lower sternal region extends from the ensiform cartilage to the third costal cartilage, and from this point to the sternal notch is called the upper sternal region. From the top of the stermine to the cricoid cartilage is the suprasternal region. The limits on the right and left are perpendicular lines drawn from the tips of the acromions. At the side the axillary region extends from the summit of the axilla to the sixth rib, and below this is the infra-axillary space, extending to the bottom of the chest.

The abdomen is divided into nine regions for purposes of description, as follows: Draw a horizontal line across at the level of the narrowest part of the waist and a second line at the level of the iliac crests. Draw a perpendicular line from the middle of Poupart's ligament, on each side, extending up to the chest. On the outside of these lines will be found, above, the right and left hypochondriac regions extending down to the first horizontal line. Between the horizontal lines will be the lumbar regions and below these the iliac regions bounded by Poupart's ligament. The central portion is called the umbilical region. Above this is the epigastric and below the hypogastric regions.

In examining a subject by percussion it is well to begin on the supra-clavicular region and percuss lightly and then forcibly *on each side*, and press the fingers well against the intercostal muscle rather than over the ribs, while proceeding to the lower edge of the chest; then purcuss the right axillary region; then the posterior thoracic, from top to bottom, striking on alternate sides in order to discover any difference in sound that may exist, and then the left axillary space. There should be equal resonance of sound on each side behind, unless there be extreme unevenness of muscular development, which will slightly dull the sound on the strong side; but in front the location of the heart

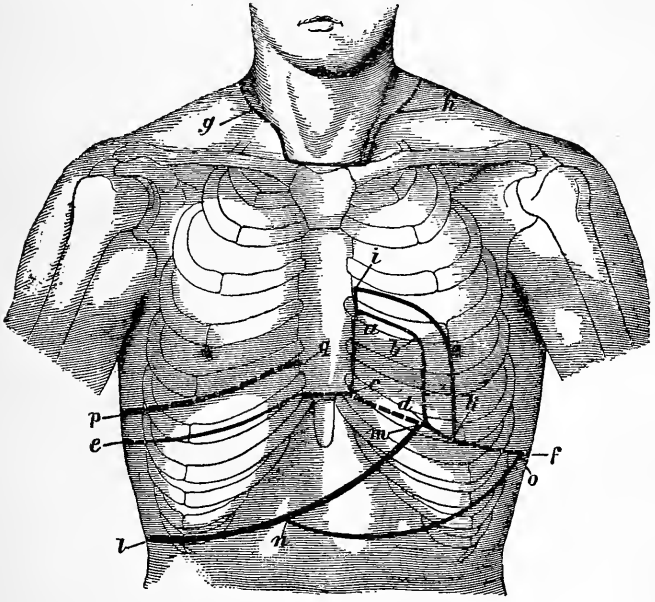


Fig. 20.

Showing the areas of percussion dullness and flatness over heart, liver, and stomach. *i. k.* line of beginning dullness around the heart. *a. b. d. c.* area of flat sound or without pulmonary resonance. *p. q.* line of dull area over the liver. *e. c. m. l.* area of flatness over liver. *m. n. o.* area of varying resonance over the stomach. Weil.

to the *left* of the sternum, and the liver to the *right* of it, and lower down gives a wide variation in sound for similar locations on the two sides. On the right we usually find the point of liver dullness beginning about 2^{cm}. below the nipple, while the line of flatness is about 6^{cm}. below it—the flat area extending about the breadth of the hand or to the edge of the ribs, and around to the spine. See Fig. 20. On the left the area of heart dullness begins at about the third intercostal space, near the sternum and extends out to a point nearly an inch above the nipple, and down for 3^{cm}., shading off into the flat heart area—that

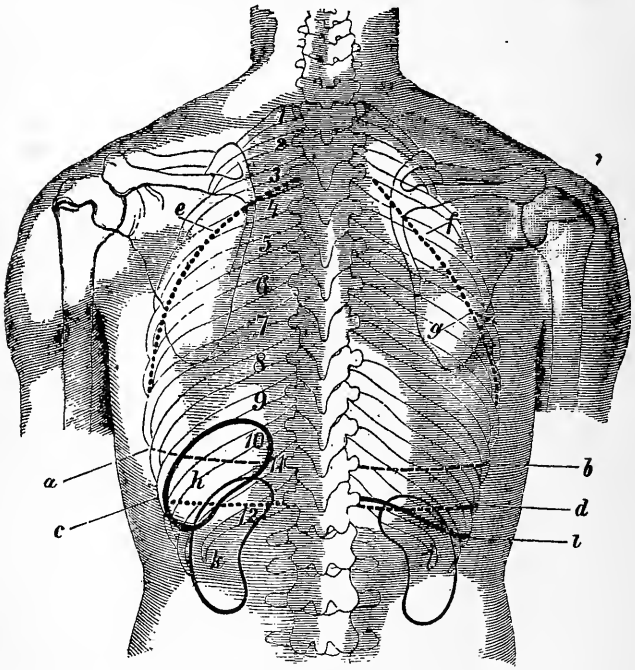


Fig. 21.

Showing the positions of the kidneys, *j. k.*, and spleen, *h*; margin of liver, *l*. The dotted line, *e. f. g.*, shows the lobar divisions of the lungs. Scheube.

is circular above about 5^{cm}. in diameter and having its center at a point half way between the nipple and the center of the end of the sternum, and reaching downward to the sixth rib, where it is merged in the stomachic resonance. See fig. 20.

The line of stomach dullness is of variable location and may not be perceptible at all.

The percussion sound of the abdomen is tympanitic or flat, according to the existence of gas in the intestinal canal. In cases of ascites, a peculiar wave impulse is started by immediate percussion that is readily felt by the other hand held against the abdominal wall opposite the point of impact. The same is true of cystic tumors in other locations, where the walls are protected only by soft tissues, as in effusion into the synovial cavity of the knee and other joints, as a result of inflammation or hemorrhage. This wave impulse corresponds to the fluctuation of palpation. See page 81.

The area of liver dullness should not extend below the lower edge of the ribs, on the right side, while the spleen is found well around to the left side, extending from the line of dullness at ninth rib, downward about eight cm., the breadth being about half this distance. See fig. 21. In ordinary cases the spleen is not to be sought, as its function is not fully known, and its recognized abnormalities are confined to malarial and congestive fevers, with occasional malignant growths. The length of the thorax will be found to vary greatly in different people, and, where the ribs come well toward the umbilicus, the liver should hardly reach to the lower edge of the ribs, except in front, while in the cases of short chest it may extend five or more c. m. below the free margin. The left lobe extends across the median line for about six or eight c. m., (fig. 19) where its limits are not readily discovered by percussion, on account of the area of heart dullness. At the right side the liver extends down to the tenth intercostal space, and behind it reaches to the last rib. See fig. 21.

It should be remembered that the lower limits of the liver may vary greatly without its being an indication of enlargement or disease. In examining this organ, therefore, it is well, if any apparent malformation exists, to determine by percussion, and mark with a flesh pencil the outline of the organ. The exact measurements can then be made and malposition differentiated from hypertrophy.

Some of the more common causes of malposition are tight lacing, pleuritic effusion, congenital and traumatic malformations, pericarditis with effusion, and certain abdominal tumors. For convenience in treating the normal positions of certain organs, the following points should be fixed in mind:

The sternal notch is on a level with the top of the second dorsal vertebra or tip of seventh cervical spine.

The spine of the scapula is on a level with the third dorsal spine.

The lower angle of the scapula is on a level with the seventh dorsal spine.

The base of the heart lies at the fourth dorsal spine.

The apex of the heart lies at the level of the eighth dorsal spine.

The apex of the lung lies opposite the seventh cervical spine and vertebra, and from two to four cm. above the top of the sternum.

The base of the lung is on the level of the tenth dorsal spine.

The spleen lies on the level of the ninth and eleventh dorsal spines.

The upper convexity of the liver lies on a level with the eighth dorsal spine or slightly above the lower end of the sternum.

The nipple usually covers the fourth intercostal space at level of sixth spinous process.

These locations are all referred to the spinous processes of the vertebra as fixed points that can always be found. If we rub the ball of the thumb firmly down the furrow

between the erector spinæ muscles, the tips of the spinous processes will show as pink spots on the skin. This method is recommended by Dr. Holden to determine the existence of lateral curvatures.

In auscultation we have the method of most precise knowledge in diagnosis. By other methods of examination we may learn that there is something wrong, but the ear is the supreme court to decide the case and tell what that "something" is. For purposes of auscultation several instruments have been devised, but none better for general use than the binaural stethoscope of Dr. Camman (see Fig. 8), with its improvements for clàsping into the ears, without undue pressure. The unassisted ear is able to do all that is required in most cases, as the sounds are equally distinct, but the ear can not be readily applied to all parts of the chest, and to attempt it in some cases would be to affect other parts of the sensorium with more profound salutations.

The stethoscope also enables us to localize sounds closely by making a direct course of travel for sound-waves. Consequently, it readily transmits those waves that pass directly into its bell or tube ; while those waves that are not thrown directly in, are either lost or become obscure, so that our attention is centered on the sounds produced directly beneath. The pressure of the aural tips closes the external meatus of the ear, so that foreign sounds are entirely eliminated.

The following points in the use of the instrument should be borne in mind :

1. Apply the instrument to the ears so that the aural tips will point *downward* and *inward*, thus following the direction of the meatus of the ears.

2. Have just sufficient pressure in the ears to hold the instrument steady and make the tips fit perfectly.

3. Let no foreign material touch against the stethoscope at any part of it during use, as friction-vibrations will be set up.

4. Press the bell firmly over the spot to be auscultated, so that it fits the integument perfectly all around. If the surface is uneven, the soft rubber bell should be used.

5. Do not let the fingers move on the instrument while holding it in place.

6. Always apply directly to the skin, as nothing satisfactory can be heard through even a thin layer of cloth. (See page 30.)

7. The examiner should keep his own head as nearly erect as possible to avoid cerebral congestion from venous constriction.

Where the naked ear is used, a soft cloth can be interposed between it and the subject.

In listening to the sounds of the mitral and tricuspid valves with a stethoscope, it is well, should there be doubt in diagnosis, to place a thin cloth, like a napkin, on the chest, and auscultate through it. The only sound heard through this will be the valvular click—the first sound becoming short and uncomplicated like the second sound.

In auscultation continued practice must be given to learning normal sounds and their relations. If the examiner knows every healthy sound with its variations, he will instantly recognize an abnormal one, even if he is not able to clearly state or even understand the existing lesion. Some sounds are so complicated as to defy experienced surgeons in reading their significance.

The following points are to be studied:

(*a*) Muscle-sounds, by placing the stethoscope over a muscle like the biceps, during its contraction and relaxation.

(*b*) Heart-sounds, by studying the sound at each location in the precordial region and along the large arteries.

(*c*) Lung-sounds, in every region of the chest.

(*d*) Intestinal-sounds, that are caused by the gases of fermentation.

(*e*) Succussion or splashing sounds of fluid in the stomach (or chest), while it contains free gas.

(*f*) The "bruit" or hum heard in many cases over the large venous trunks, especially of the neck and upper chest, and over aneurismal sacs.

A muscle sound is of low pitch and vibratory quality—a rapid throbbing as it were. Its character is represented in exaggerated form by moistening the end of the thumb and then rubbing it along the surface of a wooden table with a fairly rapid movement. The thumb will jump along the surface giving a low vibration to the wood. This muscle sound is the cause of the peculiar, prolonged, "booming" sound of the heart during its contraction, and it modifies the valve sound of closing to some extent; therefore the directions on page 30 should be followed if there is an apparent systolic murmur.

The valve sounds are brief in duration, of high pitch and clicking or non-resonant quality. These sounds are confused more or less by the muscle sound, by respiration sounds and by the vibrations of blood currents both normal and abnormal. These abnormal sounds are generally of blowing quality and are called murmurs. They will be studied more at length in Chapter VIII. The sounds of the normal heart must be patiently studied with the stethoscope until its every peculiarity is familiar; its rythm, its force, its various valve sounds, its points of clearest differentiation of complex sounds and its transmission of sounds, the relation of the pulse in various localities to heart impact, etc. It is only by a thorough acquaintance with normal conditions that the abnormal can be recognized.

There will be found frequent cases of arterial and venous murmurs or humming sounds that will be likely to be mistaken for heart murmurs. These have a location over the larger blood vessels and the sound is continuous rather than intermittent, if of venous origin, and if arterial, the sound is usually not heard at the heart, but at some point where a large trunk makes a sharp turn as in the subclavian artery.* The venous murmur may vary from a low hum

* N. Y. Med. Rec., Nov. 5, 1887. "An undescribed arterial murmur," by H. H. Seelye, M.D.

to a whistling sound. The jugular vein is the spot where the venous hum is most frequently heard, and in many cases a hum can be produced by an uneven pressure of the stethoscope, making a slight constriction in the calibre of the vessel. Turning the face of the subject to one side will sometimes produce a hum on the opposite side. This sound has been called by some writers an anaemic hum, but its cause can hardly be assigned directly to the quality or quantity of the blood. Anaemia might be a factor in the production of the sound by causing a softening of the tissues supporting the vessel, and the watery venous blood may be sonorous to a larger extent than arterial blood, as taught by Walshe, but the direct cause must be the unevenness of the calibre of vessels, through which blood must be flowing at a speed bearing some relation to the size of their lumena.

Arterial murmurs may be due to roughness of the inner coat due to inflammations or vegetations, sacculations, or pressures. These causes would produce systolic murmurs that would be loudest over the site where they are produced. From similar causes murmurs may be produced in the cavity of the heart itself. Another class of murmurs is found in extremely nervous people, excessive tobacco users and over-trained athletes. It is due to irregular muscular action of the heart, with consequent imperfect closing of the valves, and is therefore systolic and heard more commonly over the base of the heart. These murmurs are not constant, and do not frequently, if ever, exist with benign hypertrophy.

Heart murmurs due to dilatation of the cavities from anaemia do occur, and in those cases it is difficult to decide whether there is aortic obstruction or a simple dynamic murmur. In the first case, however, we would find a powerful heart impulse from hypertrophy, while in the second there would be a feeble impulse from the imperfect contractions. At times the respiratory sounds may confuse the heart sounds by the air being driven out of a

portion of the lung by the heart impulse, giving rise to a sound that may be mistaken for a heart murmur. This sound would be systolic and not heard at the apex.

It is well, then, in examination, to apply the stethoscope to the apex of the heart first and then over the base, listening carefully to the valvular sounds and asking the subject to suspend respiration in expiration for a moment if any abnormal sound is heard. Then listen over the carotid and subclavian arteries on each side. If a humming sound is heard that can not be understood, let the subject take some of the gentler strength tests, and after a slight acceleration of the pulse listen again, and so proceed until he understands the case. The case may not be one to be determined in a few minutes or days.

In listening to the sounds of the lungs we must also have a fixed idea of the normal before endeavoring to study abnormal sounds. In perfect health the normal vesicular murmur of the lungs varies within quite wide limits of force, pitch, quality and duration, due to the difference in thickness of the chest wall and the activity of respiration in different individuals, but the general character of the sounds remains the same.

This sound has been likened to the faint rustling of dry leaves or straw, but the only description that is of help to a student, is the one that he makes to himself by continuous use of the stethoscope and naked ear applied to the chest.

The following points may be borne in mind as helpful in examination :

1st. The murmur is shorter in expiration than inspiration, and in some cases the murmur is entirely suspended during expiration.

2d. The murmur is harsher over the region of the larger bronchial tubes, becoming milder as we pass downward to the base.

3d. The heart sounds will tend to confuse the lung sounds in the front of the left lung, but only in a few cases is it difficult to hear only the sounds you search for.

4th. The sounds of bronchial breathing are heard in simple, uncomplicated form, over the trachea and upper sternal region.

5th. the quality of bronchial respiration sound is tubular and harsh ; the pitch is high.

6th. The expiration sound is longer than inspiration in the region of pure bronchial breathing.

7th. Vesicular or fine respiratory murmur is heard to the lower margin of the lung tissue.

8th. If the murmur ends abruptly at any point above the natural border of the lung, and the murmur is normal, suspect an effusion into the chest cavity.

9th. Normal flatness may begin as high as the sixth rib on the right side, and at the seventh on the left.

The abnormal respiratory sounds are called râles. They are in general of the bronchial type rather than the vesicular. The sounds may be dry and rasping as when the tubes are contracted by an inflammation at the initial stage or a spasm of the muscular fibres of their walls or by local pressure. The sounds are called moist when the tubes are obstructed by more or less fluid. These râles may be so loud as to obscure the vesicular murmur.

The crepitant râle is a fine dry, crackling sound, heard in the last part of inspiration in pneumonia and phthisis, and has been compared to "the sound produced by rubbing a small wisp of hair between the thumb and finger near the ear," "pulling postage stamps apart," etc.

The subcrepitant râle is heard in bronchitis, pneumonia, oedema of the lungs, phthisis, etc. It is a fine, moist, bubbling sound, heard in both inspiration and expiration.

Coarse bronchial râles are heard in bronchitis, phthisis, etc., and are caused by mucous interrupting the flow of air. These râles may be so loud as to be heard without applying the ear to the chest and if the mucous is very dry a whistling sound will be produced.

Gurgling râles are sometimes heard, especially if the subject is very weak and can not expel thin mucous from

the larger tubes or if there is a cavity in the lung from tubercular degeneration.

Aside from the respiratory sounds the vocal resonance is of importance in determining the condition of the lungs.

1.—The *laryngeal voice* is heard over the trachea and large bronchial passages, while in the general area of the chest the sound is modified and softened, until the vocal expression is lost except over the right bronchus, and, in thin persons, the left.

2.—This tone with "far-away" quality is known as the *pulmonary resonance.* It corresponds to the vocal fremitus of palpation.

3.—Increased resonance indicates some consolidation of the lung without closure of the bronchial tubes, cavities, pleuritic adhesions or compressed lung tissues from effusions.

4.—Diminished resonance is due to obstruction of the bronchi or a layer of fluid between the lung and chest wall.

5.—Suppressed resonance is caused by large effusions in the pleural sac, with compression of the lung or new growths.

6.—Broncophony or a development of the bronchial type of resonance in unusual locations indicates a condensation or hardening of lung tissue, or cavities.

7.—Amphoric resonance indicates very large cavities, or pneumohydrothorax. The quality of the sound is musical and metalic; the pitch is high and the resonance hollow and without articulation.

8.—Whispered resonance is found in as many forms as vocal resonance, and its modifications are due to the same causes. It is a more delicate test of slight consolidation and hence should be thoroughly studied. In normal cases it presents a soft blowing sound at the upper part of the chest only, where consolidation usually begins.

9.—A cough resonance is helpful at times in securing cumulative evidence of a condition suspected from other sources of information. This is specially true of the diagnosis of cavities.

CHAPTER VIII.

THE SIGNIFICANCE OF CERTAIN PHYSICAL SIGNS.

In considering the sounds of the heart it is well to bear in mind the anatomical features of the heart, and the course of the blood as it passes into the heart and through it to the aorta. The blood from the lower parts of the body is conducted by the inferior vena cava to a point near the heart where it meets the current brought from the upper parts by the superior vena cava, and unites with it to form the innominate vein which empties into the right auricle after a length of 30 to 40^{mm}. There is no valve at the mouth of this vein, but blood can flow backward through it under pressure. The right auricle is a pouch-like sac with only a small amount of muscular fibre in its wall. This auricle acts as a reservoir of a fairly steady current whose contents are discharged at intervals into the ventricle or muscular compartment directly below it. This act of discharge is easy during the period of diastole or relaxation of the ventricular muscle, and is accomplished by gravity and the contraction of the auricular walls. When the ventricle is distended with blood the muscular walls begin to contract, and the blood is forced toward the two openings, the pulmonary artery and the auriculo-ventricular passage, but this latter is fringed by the tricuspid valve which is quickly closed by the current and the blood sent on to the lungs. At the opening of the ventricle into the pulmonary artery there is a valve composed of three semilunar flaps of pocket shape, which prevents a return current after the contraction or systole has ceased.

After passing through the pulmonary tissue the blood comes back to the left side of the heart and enters the left

auricle by the pulmonary veins which are ungarded by valves to prevent a regurgitation. The right auricle is very similar to the left in function and anatomical character. From it the blood passes down into the left ventricle during its period of diastole, and is prevented from flowing back during the powerful contraction of the ventricle by the mitral or bicuspid valve. This closure of the auricular orifice leaves only the opening of the aorta by which the blood must be driven out, and which then conducts it to the general circulation. At the aortic opening are located semilunar valves to retain the blood that has once passed into the arterial trunk, so that it can not flow back and refill the ventricle during its period of receptivity.

It is clear, then, that in normal heart action we must have four valvular sounds, and these must all originate at points at no great distance from each other. In fact a circle of 25^{mm}. radius drawn from a center at the sternal end of the fourth costal cartilage on the left will cover the four valves. There are points, however, where each sound is heard more plainly, and these are for the mitral valve at the apex of heart; for the aortic valves at second intercostal space just at the right of the sterum, and over the right common carotid artery; for the tricuspid valve at middle of the sternum at the level of the nipple; for the pulmonary valve at the left of the sternum in the second intercostal space. The mitral and tricuspid sounds must be at the beginning of the systole, and are called the first sound of the heart while the semilunar closings will be at the end of the systole, and are called the second sound of the heart. The first two sounds are synchronous, and also the last two.

The first sounds are prolonged by the muscle vibration into a full booming sound, while the second sounds are short and clicking. Foster illustrates the difference by pronouncing the words loob-düb in the same relative time as the heart sounds. Between the second and first sounds is an interval that is essentially two-fifths of the time

required for a complete cycle of heart action. This is called the period of rest.

The following table is a summary of normal heart sounds:

NORMAL HEART-SOUNDS.

Sounds.	*Location.*	*Where Heard.*
1. Muscular.	Within boundary limits of heart or precordial area.	Heard best at apex and just above.
2. Mitral valve.	Behind the 3rd left intercostal space and 4th costal cartilage about 20mm. from sternum.	Just above apex beat and at 3rd intercostal space on left of sternum.
3. Aortic valve.	Behind the left edge of the sternum at the level of the 3rd intercostal space.	At 2nd intercostal space on right of sternum, and over the common carotid arteries.
4. Tricuspid valve.	Behind the sternum at the level of the 4th costal cartilages.	At lower end of the sternum above the ensiform cartilage.
5. Pulmonary valve.	Behind the junction of the 3rd costal cartilage with the sternum on the left. About in front of the aortic valve.	At 2nd intercostal space to left of the sternum.

The boundary limits of the heart as given by Holden are as follows:

For the base draw a horizontal line over the third costal cartilages extending 12mm. to the right and 25mm. to the left of the sternum. For the apex draw a perpendicular line 50mm. long downward from the left nipple and from its lower extremity draw a horizontal line 25mm. to the right, which will bring the pencil over the apex to the heart in the fifth intercostal space. The nipple is usually located over the fourth intercostal space. From the apex draw a curve to the end of the sternum, and continue it up more sharply to the right edge of the sternum, and continue it upward to the right end of the base line by a gentle curve. The left side will be marked by a curve of about 200mm. radius extending from the left end of the base line to the apex. See Fig. 19.

The part of the heart not covered by lung tissue is incon-

siderable, and is described by Dr. Latham as being outlined roughly by a circle of 25^{mm}. radius drawn from a center half way between the nipple and lower end of the sternum. Fig. 20.

Abnormal heart sounds are usually called murmurs, and result from four causes:

1. The failure of valves to perfectly hold the blood from leaking through.

2. The narrowness of the opening through which the blood is forced into a tube of larger caliber.

3. Friction of the external surface of the heart against an inflamed pericardium.

4. Friction on endocardium from vegetations.

The first cause may be due to active inflammation of the valves from endocarditis, etc., that produces vegetations or uneven thickening of the valves and therefore imperfect closure, or the walls of the heart may become so distended as to prevent perfect coaptation of the valves. Other causes also may produce imperfect closure.

The second cause usually depends on inflammation that has caused a deposit of fibrous tissue around the orifice affected.

The third cause is more often the result of an injury or strain, and is found in some cases after violent exercise.

The fourth is found after fevers, rheumatism, etc.

The character of these abnormal endocardial sounds is hissing or blowing, and for this reason they are called by some writers "bellows murmurs," while the friction sound is more squeaking or grazing in its quality, and can frequently be diagnosed by the fremitus discovered by palpation.

The pitch varies in all the sounds from a low, gentle murmur to a high whistling note—the pitch giving us some idea as to the size of the opening; for if the sound be caused by a stream forced through a small aperture the pitch will be higher—the surfaces set in vibration being much shorter than in the large opening.

The most common heart lesion is a failure of the mitral

valve to perfectly close the left auriculo-ventricular passage. This is called mitral insufficiency. It is plain, that any fault in the closing of this valve would permit the blood to flow back into the left auricle during systole, and that this would cause increased pressure in the auricle and pulmonary veins, thus interfering with respiration and distending the auricle. As the heart contraction forces blood into the aortic arch, there is an effort toward straightening the aortia from the pressure, and this brings the apex of the heart against the chest wall at about the fifth intercostal space. This brings a continuous vibratory medium of solid tissue from the point of vibration to the external surface where we may receive it by the ear or stethoscope. We also find that the sound is carried to the left axillary region along the fifth or sixth rib. The sound is heard over the valvular region at the base of the heart but without characteristic qualities. The time of the murmur is during the systole, and hence it begins with the valvular click of the first sound and ends with the second valve closing at the aorta which gives the second sound.

If the heart sounds are so deranged that it is difficult to decide which is the first sound, it may be determined by remembering that it is synchronous with the impact of the apex against the chest wall, and also with the pulse wave in the carotid arteries.

The following sphygmogram shows the typical disturbance of the arterial pressure in mitral regurgitation Fig. 24 :

The curve is not abrupt in the systole, and the pressure is not sustained to the dicrotic wave. If the systole is very energetic the pulse would be large but soft. The rhythm is irregular. Fig. 25 shows mitral regurgitation with slight aortic insufficiency. In order to understand the meaning of these curves, let us study briefly the normal pulse tracing.

Fig. 24.

Fig. 25.

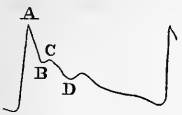


Fig. 26.

"All scientific investigators agree that the line A represents the cardiac contraction, the impulse being conveyed to the needle through the arteries in the same manner that the impulse is given to the last marble in a row of marbles by striking the first marble in the row a quick blow, the difference being that the row of marbles does not advance, while the blood current does. This ascent we will call the systolic wave.

The arteries thus suddenly filled begin immediately by virtue of their elasticity to contract and the needle descends to the point B. Next we have a wave, the cause of which is not definitely settled. It is generally believed that the wave B–C, called the tidal wave, is due to a rebound of the blood from the terminal vessels or capillaries, for the following reasons:

The tidal wave is more perceptible nearer the capillaries.

The base of tidal wave approaches the systolic line and systolic apex the farther the tracing is taken from the heart.

Sweating renders the tidal wave less perceptible and the base nearer the dicrotic notch.

From C the artery again contracts till the needle reaches point D. The rise at D is generally conceded to be due to the rebound of blood from the closed aortic valves and is usually termed the dicrotic wave. The remainder of the cycle represents the diastole or rest of the heart."*


Fig. 27.

Fig. 27 shows a normal pulse of high tension and Fig. 28 a normal pulse of low tension.

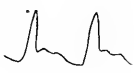


Fig. 28.

The lesion that stands second in frequency is obstruction at the aortic orifice—any narrowing of this opening that makes its caliber less than that of the aorta will produce a murmur and tend to increase the work of the ventricle with resulting hypertrophy. It obviously does not

* See an article on the Use of the Sphygmograph, by Dr. J. G. Smith, in the Annual Report of the Amer. Assoc. for the Adv. of Phy. Ed., 1888.

menace life and health to the same extent as mitral insufficiency. The sound being produced by the current forced out by the contraction of the ventricle it must be synchronous with the systole and end with the second sound of the heart. Its location being at the base of the heart, we would expect to find the sound clearest at the beginning of the aorta. It is in fact heard most distinctly over the sternum at level of the second rib or just to the right of the sternum, and is also heard over all the large arterial trunks of the upper thorax and neck. It is called aortic stenosis.


Fig. 29.

Fig. 29 illustrates the typical pulse tracing in this lesion. The systolic curve is not abrupt nor high, but the pressure is well sustained past the dicrotic notch. The pulse is small and usually regular.

The third lesion in frequency is a regurgitation of blood through the semilunar valves from the aorta into the left ventricle. Evidently this can only occur during the diastole of the heart. It should be heard in the same locations as the murmur of aortic stenosis, and also down along the sternum. The lesion is termed aortic insufficiency.

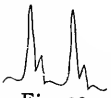


Fig. 30.

The interference with the pulse is shown by Fig. 30. Its characteristics are marked. The systolic curve is high and abrupt. The fall is abrupt. The dicrotic wave is small. The pulse is quick and strong; the "bullet" pulse.

The fourth lesion producing a characteristic sound is mitral obstruction due to stenosis of the left auriculo-ventricular passage. This would interfere with the passage of blood from the auricle to the ventricle in the period of diastole. The murmur being started during the stage of auricular contraction and ending with the beginning of the first sound; it is called presystolic. It is heard over the mitral valve and at the apex of the heart, but is not transmitted over a large area. This lesion leads to much pulmonary disturbance on account of the increased blood pressure in the lungs.

The fifth lesion is obstruction of the pulmonary orifice from stenosis. This would place extra work on the right ventricle, which hypertrophies by natural accommodation. The murmur must be systolic and heard over the second cartilage to left of the sternum. It is prolonged upward and to left of the sternum for only a short distance as the artery soon divides into small branches to ramify through the lungs.

The sixth lesion is a regurgitation through the tricuspid valves due to insufficiency of the closure. It is systolic and causes great increase of venous pressure by the current forced back into the auricle and through it into the venous trunks causing a venous pulse. It is heard at junction of ensiform cartilage with the sternum and to the apex.

The seventh lesion is an obstruction of the right auriculo-ventricular opening by narrowing, and hence the murmur must be presystolic.

It is heard over the middle of the sternum at level of fourth cartilage, and is not transmitted except to a slight extent downward to the end of sternum. It is called tricuspid stenosis.

The eighth lesion is a regurgitation through the valves (semilunar) at the opening of the pulmonary artery, and is termed pulmonary insufficiency. It tends to enlargement of the right ventricle, and interferes with the pulmonary circulation and aëration of blood. In time it must be diastolic, and is heard at the region of the second left costal cartilage. The sound is carried along the sternum faintly.

A murmur is transmitted, in general, by the blood and hence in the direction of the current.

If these lesions be tabulated in the order of their frequency, it will be observed at once that the left side of the heart is most frequently affected—all possible abnormalities having representation before the most frequent murmur of the right side. The reason for this is clear when we consider the vastly greater extent of tissues to be supplied by the left side of the heart compared with the pulmonary circulation supplied by the right.

TABLE OF ABNORMAL HEART SOUNDS.

Endocardial murmurs.

Condition.	*Heart Sound.*	*Heart Action.*	*Where Heard.*	*Transmitted.*	*Lesion.*
1. Mitral regurg.	1st sound.	Systolic.	Mitral area and apex.	Along 6th rib to axilla.	Mitral insuf
2. Aortic obstruct.	" "	"	2d rt. cost. cartil. at sternum.	To top of sternum and arterial trunks.	Aortic stenosis
3. " regurg.	After 2d sound.	Diastolic.	2d rt. cost. cartil. at sternum.	Down along sternum.	Aortic insufficiency
4. Mitral obstruct.	" " "	"	Mitral area and apex.	Not transmitted.	Mitral stenosis
5. Pulmon. obstruct.	1st sound.	Systolic.	2d left cost. cartilage.	Up a short dist., ends abruptly.	Pulmonary stenosis
6. Tricusp. regurg.	" "	"	Just above ensiform cart.	Down a short distance.	Tricuspid insufficiency
7. " obstruct.	After 2d sound.	Diastolic.	Sternum at head of 4th rib.	Not transmitted.	Tricusp. stenosis
8. Pulmon. regurg.	With 2d sound.	"	2d left costal cartilage.	Up a short distance.	Pulmonary insufficiency

The exocardial murmur is due to the movement of the heart rubbing two inflamed and roughened surfaces together. The pitch is usually high and quality squeaking. It has no connection with the valve sounds in time or location—is not transmitted in any particular direction, and if loud, may be felt as a fremitus at the apex beat. It has no influence on the pulse curve.

The Pulse of Mitral regurgitation:
(a) Compensated, is soft and often large.
(b) Uncompensated, is soft and short (celer.)
" " " " stenosis is small and soft (sometimes frequent and often irregular).
" " " Aortic regurgitation is quick, large, "shotty pulse" (and regular).
" " " " stenosis is small and long (tardus).
" " " Tricuspid regurgitation is venous.

There is a normal venous pulse. In time it precedes the arterial pulse, and may be said to alternate with it. It is caused by the auricular systole and the consequent stopping of the free current toward the heart.

The abnormal venous pulse is discovered most easily at the lower part of the jugular vein, and is synchronous with the arterial pulse, being due to the same cause, namely, the systole of the ventricles. This indirect current can be forced into the veins only when there is insufficiency of the tricuspid valve.

CHAPTER IX.

PRESCRIPTION OF EXERCISE.

The main object of a physical examination is to learn as many facts concerning the physical needs and tendencies of the subject as possible in order to be able to advise him properly regarding his exercise and personal hygiene. Without being able to give exactly the measures of a perfect man or woman we must have a standard of form and development that is derived from a knowledge of anatomy and experience in observing the individuals that present the highest evidence of perfect health and power. We learn also in a negative way by a study of pathological cases. The persons of impaired health can usually be so classified in groups with common symptoms that certain physical signs will be found common to nearly all in the group. Then by a study of the history of these cases we can judge with some correctness whether the physical sign stands in the relation of cause or effect to the abnormal symptoms. For instance, if we group together all cases of organic lung diseases such as tuberculosis, chronic bronchitis, recurrent attacks of pneumonia, pulmonary congestion, emphysema, etc., and find that a very large per cent. of the cases have in common poorly developed respiratory muscles, flat chests, sagging shoulders, etc., with no other common feature, we may properly conclude that a chest of this type is not an ideal in the sense of being a model toward which we should endeavor to conform the flexible chests of our people.

But our inference might be very far from truth and untrustworthy if we did not also approach the subject from a different line of study and reach the opinion in a positive way. We do this by grouping the individuals that have

proved their ability for enduring prolonged mental and physical strain, the superior individuals of society like Bismark, Gladstone, Greeley, Webster, etc. If we find in this group the physical conformity of chest exactly opposite to our other group, we have added to our knowledge of what should be avoided, a type that may wisely be followed.

It is often a question how far the æsthetic sense may guide us in deciding as to a physical standard. The eye will ordinarily be pleased with the form that has scientific perfection. A well rounded and developed body is more pleasing than a lax, untrained one, but there may be sentiments and unjust standards of criticism, the result of faulty training in youth, that bias even our judgments of beauty.

This is seen everywhere in the world of fashion. A head of hair that is considered beautiful and becoming one season must be bleached or dyed to some other color in order to be "perfectly lovely" the next. This depraved taste that approves of a pale face and crooked spine in a student, and a narrow waist with constricted chest and pelvic displacements in a woman, must be educated up to the scientific and artistic standard. We must show in the gymnasiums that increased health means not only increased ability, but increased beauty, and that health is only a correct balance of functional activities. It cannot exist in perfection if one part is under-developed or over-developed.

This brings us to the first point in prescription. If we discover an abnormality of shape due to extraneous causes we should first prescribe the removal of these causes when possible. To forget this would be to give medicine to counteract a poison while permitting the patient to ingest the deadly substance. In work with both sexes the matter of dress should be inquired into where we find any suspicious abnormality of shape. This is especially true of constrictions of the trunk. Boys will often wear a belt in imitation of some noted "slugger" or local "tough," or for other reasons known only to themselves. The injurious

effects are the same as may be seen in the case of corset-afflicted women; weak lumbar muscles, narrow loins, pendent abdomen, varicose veins, costal respiration, digestive ailments, etc.

The muscular weakness can not be cured while circulation is impeded by pressure on the fibres; the narrow waist can not be brought out into correct outline, to give room for a proper location of the digestive organs, that would relieve the supra pubic distention, while every force is crowding them down into the pelvis.

The respiratory act should be unimpeded or imperfect oxidation will result and this means virtually an enforced vitiated atmosphere. A reduction of waist-girth by 50^{mm}. is shown by Dr. Sargent to reduce the lung capacity twenty per cent. A number of persons with an average lung capacity of 2.70 litres, and waist girth of 710^{mm}. were found to have a lung capacity of only 2.15 liters when the waist girth was reduced to 660^{mm}.

A reduction of the oxygen in the air by diluting it with nitrogen or carbon dioxide to the extent of one-fifth (20 per cent.) would soon be disastrous to active life. Again, constriction of the waist calls for an entirely artificial method of respiration, as has been conclusively shown by Dr. Kellogg, through whose courtesy the following illustrations of normal and abnormal respiration are given on pages 110, 111, 112.

After looking at these illustrations, that explain themselves, two questions might be suggested by any person not fully acquainted with Anatomy and Physiology: 1st, Does not the amplification of the costal curves during compression show that the respiratory act is fairly complete—one set of muscles acting when the other is impeded? This view has been presented in articles by Dr. Mays, to which reference has already been made, who attempts to show that this method of breathing may tend to prevent tuberculosis by causing a better action of the apices of the lungs where that disease usually locates. The only support brought to this theory was the fact that more men than

PLATE I.

Costal. **Abdominal.**

Fig. 1. Man.

Costal. **Abdominal.**

Fig. 2. Civilized Woman (Unmarried, age 33 years).

Costal. **Abdominal.**

Fig. 3. Chinese Woman.

Costal. **Abdominal.**

Fig. 4. Indian Man (Chickasaw).

Costal. **Abdominal.**

Fig. 5. Indian Woman (Chickasaw).

Costal. **Abdominal.**

Fig. 6. Chippeway Indian Woman.

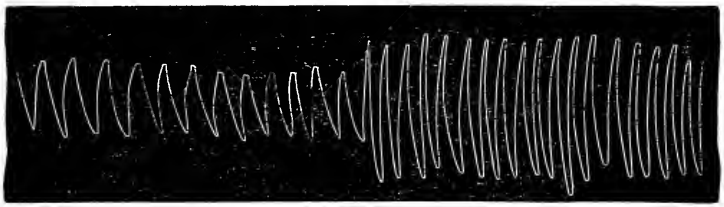
PLATE II.

Costal. **Abdominal.**

Fig. 7. A Scotch Woman, who has never worn a corset (age 45, unmarried).

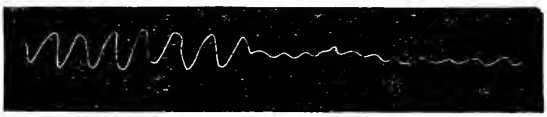
Costal. **Abdominal.**

Fig. 8. A Reformed Corset-wearer (ordinary respiration)



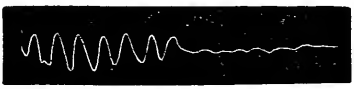
Costal. **Abdominal.**

Fig. 9. Reformed Corset-wearer (forced respiration).



Costal. **Abdominal.**

Fig. 10. Young Woman in Corset.



Costal. **Abdominal.**

Fig. 11. Man in Corset.

Costal. **Abdominal.**

Fig. 12. Male Dog.

Costal. **Abdominal.**

Fig. 13. Female Dog.

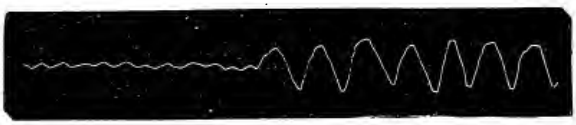
PLATE III.

Costal. **Abdominal.**

Fig. 14. Woman at Seventh Month of Pregnancy.

Costal. **Abdominal.**

Fig. 15. Woman, a Week Before Confinement.

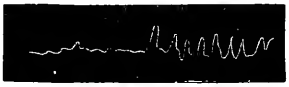


Costal. **Abdominal.**

Fig. 16. Man with Enlarged Spleen.

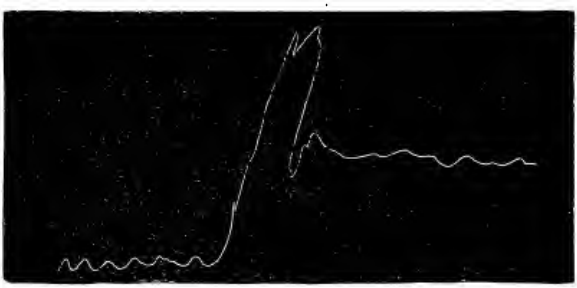
Ordinary. **Forced.**

Fig. 17. Respiratory Tracing (Vaginal).



Ordinary. **Forced.**

Fig. 18. Vaginal Tracing, with Corset.



Without Corset. **Tightening Corset.** **With Corset.**

Fig. 19. With and Without Corset.

women die of pulmonary tuberculosis; but when we remember that this disease is largely due to climatic influences of which wide and sudden variations are the chief feature, and that men are more exposed to these variations than women, the argument seems worthless.

But even if we concede a possible safeguard against tuberculosis in tight lacing we must still look upon it as a case where the remedy is worse than the disease, or a disguised blessing of the kind described by "Josh Billings," who remarked that "tight boots are a blessing, inasmuch as they cause a man to forget all his other miseries."

2nd, If costal respiration is prejudicial to health why do we not have a larger death-rate from acute lung diseases and other diseases directly traceable to interference with respiration?

The reply is ready that the impaired activity of one organ rarely gives evidence in physical signs of its abnormality. Even as sensitive an organ as the brain may disclose its disordered function, not by pain in the head, but by an abnormal secretion in some remote organ; or a disease of the kidney be discovered by its causing an organic change in the heart. The lungs are ordinarily capable of enduring great hardship. Their flexibility enables them to conform to any shape of the thorax or to be compressed for a long time by a pleuritic effusion, or other cause, without permanent injury, as is frequently seen in cases of extreme kyphosis. According to the statistics of the New York Mutual Life Insurance Co., consumptives average one and a half inches less in chest girth than non-consumptives. But meanwhile how fare the organs that are dependant on good blood? The brain can not act well from the instant unoxidized blood which flows in to supply it. Lowered vitality is the result with a yielding to acute diseases of every kind. Many a death is recorded as due to typhoid fever, peritonitis, malaria, etc., that is really due to a deficient respiration when the system requires the most active oxidation. The respiratory power is recognized as of the highest importance in all acute diseases.

We must see to it, then, that no article of clothing interfere with the free action of every organ.

The same care must be exercised in judging whether or not a bad form is due to faulty habits of posture. If the respiration is checked by a position that brings a bend in the trunk with a depression across the upper part of the abdomen, as is the case when one slides forward in his seat until the sacrum instead of the ischia bears the weight of the body, the same ill results will be found that are noticed in tight lacing.

The horizontal depression due to the above cause will sometimes be found as high as the fifth rib and we can readily understand the interference with circulation that must exist in such cases. In all there will be more or less disturbance of the hepatic function, impaired digestion, constipation and atrophy of the lumbar muscles.

The muscular condition of the loins and abdominal wall can tell us much about the digestion and nutritive powers. If these muscles are weak we must point out the fact with emphasis and order such exercises as shall tend to give strength and activity to them. The small size of a man's biceps or gastrocnemius often troubles him when his real anxiety should be regarding his erector spinae or rectus abdominalis.

It is the essentials that we must lay stress upon in our prescriptions, for the other parts will get incidental exercise in almost every case. A person's arm will always be large enough for the ordinary demands of life upon it—his heart may not be ; his leg will always be strong enough to fill every requirement—his stomach may fail utterly. A man may have life and fair health with complete loss of some muscles, while others act at the seat of life itself.

A class of cases will come under the care of the instructors in the gymnasiums of Schools and Colleges that will be rarely met by the Directors of other gymnasiums ; a set of boys and girls who have been overworked mentally and underworked physically, until the nervous side of

their lives is far in the ascendant. The whole idea of physical exercise has become repulsive to them because their muscular tissue is so weak that any fair activity begets great weariness, and sometimes even lameness. Brain work is easy for them because it has become the habit of their lives; they can generally accomplish great feats in the way of bearing severe strains of short duration, both mental and physical. They can sit up all night preparing for an examination, and the next day are bright and ready for good work, or, at the time of physical examination they show a surprisingly high record in strength tests, but come in the next day to tell of a strained back or lame shoulder as the result of their lifting. They make good athletes, but are continually getting over-trained. They invariably do too much.

Is gymnastic work advisable for such persons? An affirmative answer can only be given when there is to be personal supervision of the work. The boy of high nervous organization needs exercise quite as much as one who has no tendency to abnormal nerve activity, but it must be of a different character, for the results sought are dissimilar. The nervous person does not live enough in his muscles. His habit is to make excursions out into his extremities, and after stirring them up and making every tissue tingle he retires, to leave each muscle exhausted and every energy depleted. The exercise prescribed for these cases, and enforced by personal supervision, must be light, and continued over a long period of each day. To satisfy the mental requirement of the case the work must be made attractive, either as a game or a personal contest between individuals. In a few cases such an interest in the physical welfare can be excited in the subject as to take the place of this mental interest that is stimulated by games, and a person will do routine work that is laid out simply from the enjoyment that he gets from visible improvement.

Athletic work, on the other hand, is too stimulating to

the nerve centers to be advisable for such cases. The excitement of contests will leave a person exhausted, for it will continually lead him to over-exertion.. This objection does not apply to those contests where skill rather than great strength is the source of excellence.

Many of these persons, if uncared for in the gymnasinm, would shortly fall into the hands of a physician as typical cases of neurasthenia, and rest must often be prescribed instead of exercise. The Swedish system of passive movements, or massage, gives us an opportunity to develop muscular tissue even while the patient is resting, for the passive motion of the muscles tends to stimulate the circulation in the same way as active exercise, and consequently the nutrition and growth of the part is actively promoted.

Comparatively few people understand what is meant by complete rest. The complete relaxation of every tissue is a requisite of rest, and a habit of relaxation by an act of will can soon be secured. There are many noted cases of this ability to even sleep by an act of sheer will power. One of the most useful features of the Delsarte system lies in the attention that is paid to this idea of physiological rest. The effect of sunlight on these Neurasthenic cases is almost always favorable, and consequently outdoor work should be prescribed in preference to indoor work.

In marked contrast to the cases mentioned the athlete may be placed. Advice in regard to exercise will be sought, and such exercise must be prescribed as will tend to secure a development of the muscles that are least used in the particular form of exercise in which the athlete engages. Again, after a severe course of training for any athletic event, many cases will find discomfort from local congestions on account of an over-activity of the heart during the period when there is no great physiological "wear and tear" to require a very active circulation. To meet these cases a course of training must be laid out that shall be graduated from heavy work down to light, so that

the person may slowly accustom himself to the new conditions under which he must live. The heart of an athlete, who has been properly trained, is usually in good condition, and a very small percentage develop any heart lesion during their training, but a large strong heart may be an actual disadvantage to a man leading a sedentary life, as a puny, feeble heart surely is.

The examiner will find many cases of debility and nervous irritability. Among men a large per cent. of these cases will be inordinate users of tobacco. The very first glance will betray to the experienced eye the "something wrong," but we must always remember that some of the most persistent users of tobacco are strong and hearty while a few of those who do not use it are weak and nervous. How then shall we say to a person who asks our advice whether he is suffering from nicotine poisoning or not?

In the first place the heart action under continued influence of nicotine is peculiar and attention is called to the sphygmogram, Fig. 31, of a typical pulse of a "tobacco heart," from the Reference Handbook of the Medical Sciences. It will be noticed that the first two beats are essentially normal with the tidal wave as marked as the dicrotic. The interval between the second and third waves is longer than the first which may be considered the normal for this case. The third interval is short and the dicrotic notch deep while the systolic wave is not high. The fourth interval is normal; the fifth longer and followed by a very faint impulse after which the heart again rallies, and so on.

Fig. 31.

The character of this pulse as felt at the wrist is irregular and tremulous. A beat or two of high tension followed by one of low, or there may be no rythm discoverable.

These cases should be studied carefully and can readily be distinguished from the frequent pulse of nervous excitement or the palpitation and irregularity of chronic indigestion. In perhaps three-fourths of the cases there will be some nervous excitement attendant on the new experiences of a thorough examination but this influence on the pulse may be either quickening or depressing, and these changes come not for single beats but during cycles covering many pulsations.

An intermittent pulse may not be an indication of serious interference with health or longevity and may not be due to any appreciable cause. The omission is then usually found at stated intervals not very short, but from ten to a hundred beats apart.

Of course the examiner's duty is clear in each discovered case of smokers' irritable heart, and it is only suggested that other narcotic stimulants, like tea and coffee, will produce effects that are nearly similar. In these cases the exercise recommended must be light, and such as tends to relieve the circulation.

The following form of blank prepared by Mr. C. M. Williams of the St. Louis Y. M. C. A. Gym. is the best of the many that have come under the author's notice where personal explanations can accompany the directions:

Apparatus.	Move-ments.	Times.	Weight.
1. Chest Weights			
2. Giant Pull. "			
3. Low Chest "			
4. Split H'dle Giant			
5. Intercost. Mach.			
6. Abd. Giant Pull.			
7. Quarter Circle			
8. Rowing Machine			
18. Sculling Machine			
39. Paddl'g Mach.			
9. Chest Expander			
10. Leg Developer			
11. Leg Developer			
12. Neck Machine			
13. Forearm Devel.			
14. Abdominal Stool			
16. B'k & Loin Pull.			
17. Finger Machine			
19. Paral. Bar Mach.			
20. Parallel Bars			
21. Horizontal Bar			
22. Vaulting Bar			
23. Vertical Bar			
24. Floor Bars			
15. Incl. Chest Bars			
26. Ver. Chest Bars			
27. Susp. Par. Bars			
25. Vaulting Horse			
28. Vaulting Buck			
29. Inclined Ladder			
30. Horizont'l Lad.			
31. Climbing Ropes			
32. Peg Pole			
33. Climbing Pole			
34. Striking Bag			
35. Kicking Appar.			
36. Jumping Stand.			
37. Flying Rings			
38. Traveling Rings			
40. Spring Table			
Bar Bells			
Dumb Bells			
Indian Clubs			

The following directions prepared by Dr. J. G. Smith are more intelligible where the person has no direct supervision in his work:

1. For Grip and Forearm—Opening and shutting fingers with or without resistance, (*a*) wrist roller: (*b*) clubs; (*c*) bells; (*d*) horizontal bar and (*e*) rings.

2. Front Arm—Any exercise bending the elbow joint against resistance especially while rotating the thumb outwards; such as (*a*) curling dumb bells; (*b*) the pull up; (*c*) the rings; (*d*) the horizontal bar; (*e*) the high parallels; (*f*) the pulley weights; (*g*) climbing ropes and ladders.

3. Back Arm—Any exercise straightening elbow against resistance; (*a*) pushing up dumb bells; (*b*) dip on parallels; (*c*) traveling parallels; (*d*) pulley weights; (*e*) striking bag; (*f*) chest bars, either straight or inclined; (*g*) work on horse or buck.

4. Shoulders—Any exercise carrying the arm from the body against resistance, either front, back or out, with (*a*) bells; (*b*) clubs; (*c*) pulley weights; (*d*) wands, etc.

5. Neck—Bending head back, front or sideways against resistance of the hand or neck machine.

6. Chest Muscles—Any exercise tending to bring the arms across the body, whether front or back, or raising the body when arms are fixed, as (*a*) pulley weights; (*b*) parallels; (*c*) horizontal bar; (*d*) traveling parallels; (*e*) high parallels; (*f*) ladders; (*g*) chest expanders; (*h*) giant pulleys; (*i*) rings; (*j*) quarter circle.

7. Abdominal Muscles—Any exercise tending to bend the body forward against resistance; such as (*a*) quarter circle; (*b*) abdominal mat and stool; (*c*) raising from a reclining to a sitting posture; (*d*) pulley weights; (*e*) giant pulleys; (*f*) the "L" on ladders, rings, horizontal and parallels.

8. Back — Any exercise straightening or bending the body back against resistance, such as (*a*) rowing; (*b*) low pulleys; (*c*) dumb bells; (*d*) free-hand and setting up drills. (*e*) wands.

9. Front Thigh—Any exercise bending the hip or straightening the knee against resistance; (*a*) leg work of free-hand and dumb bell drills; (*b*) running; (*c*) hurdling; (*d*) jumping; (*e*) leaping; (*f*) rowing; (*g*) leg machine.

10. Back Thigh—Any exercise bending knee or straightening hip against resistance. (*a*) Second motion of West Point Setting Up Drill; (*b*) leg work of pulley weight drills; (*c*) free-hand and dumb bell drills; (*d*) striking bag.

11. Front of Leg.—Any exercise raising toes, or tending to carry body forward with bent knee against resistance; (*a*) pulley weights with back towards them; (*b*) leg work of dumb-bell and free-hand drills; (*c*) ankle machine.

12. Back of Leg—Any exercise raising the body on the toes. All exercises for front of thigh; ankle machine.

For all around development with light apparatus no better work has ever been devised than the dumbbell drill of R. J. Roberts.

Roberts' Gymnasium Dumbbell Drill No. 1.

Div. 1—Free Work.

1 Open and shut fingers.
2 Wrist shakes.
3 Wrist extensions.
4 Small circles.
5 Arm quivers.
6 Yawn stretch.
7 Windmill down in front of face.
8 Same down through sides horizontals.
9 Milkman's slap.
10 Back neck exercise.
11 Sternum expression.
12 Out-door breathing work.
13 In-door breathing extensions.
14 Massage.

Div. 2—Leg Work.

1 Raise high on tip-toes.
2 Raise sharp on heels.
3 Combine one and two.
4 Ankle cradle rock.
5 Spread eagle.
6 Raise on toes and roll the shoulders back and down.

Div. 3—Thigh Work.

1 Squat half way down.
2 Squat all the way down.
3 Combine one and two.
4 Front hammer.
5 Side hammer, No. 2.
6 4 count side pull the string.
7 Spring board jump.
8 Jump rope.
9 Stationary run with ¼, ½ turns and arm expressions.

Div. 4—Body Work.

1 Side push.
2 Sternum elevator.
3 Cradle rock.
4 The chop—vocal.
5 Shoulder raiser.
6 The cut—vocal.
7 The cut—stretch.
8 Liver squeezer.
9 The flip.
10 Yawn stretch.
11 Forward push—vocal.
12 "A" walls. (Jump feet together on last count.)
13 Push to sides horizontals.
14 Muscular chest.
15 Vertical push (pull the string.)
16 Dry land swim (forward hammer.)
17 Same side hammer, No. 2.
18 The 32 count, Nos. 1, 4, 6, 9, 11, 13, 15.

Div. 5—Arm Work.

1 Biceps—up hard.
2 Triceps—down hard.
3 Combine two and one.
4 Triceps, vocal—Hello.
5 " " —Ah.
6 Triceps, vocal—Sh.
7 Tricep swing (st. exp.)
8 Wrist twists.
9 Wrist curls.
10 Yawn stretch.

Div. 6—Extension Work.

1 Forward sweeps.
2 Side sweeps.
3 Strike, hard, behind heels and under chin and over head.
4 Clavicular exercise.
5 Trapezius squeeezer.
6 Strike behind thighs and under chin.
7 Strike over head and under chin.
8 Combine six and seven.
9 2 count side pull the string.
10 Repeat No. 7 and pull the string.
11 The scoop, (do slowly.)
12 The toe yawn stretch.

For cards or prescription blanks to be furnished to the individual examined many devices have been originated, the principal ones, containing a list of the measurements of the person, on which is marked the parts that especially need development, while on another part of the card is a reference either to apparatus or to the form of exercises that will specially tend to develop those parts. The standard that is commonly used on these cards is an average made up from the measurements of a large number of individuals. The question of what is a typical or ideal man is still an open one, however, but perhaps no better idea of such a man can be gained at present than the measurements illustrated in the chart of Dr. E. Hitchcock, Jr., as shown in Appendix 4.

We should have a standard of marking physical excellence or deficiency in a numerical way that shall in some way correspond with the mark that is given on examination for intellectual accomplishments. Francis Galton, in a paper prepared for the American Association, suggests that attention be given to this point, and says: "I would ask to be permitted to suggest a subject, or rather a very interesting class of subjects, that fall under this head; it is to investigate the best method of assigning marks for physical efficacy based on anthropometric tests. The colleges of America would greatly help in a good cause by working on the general lines suggested in this paper. I see no reason why a man's physical efficacy should not be valued in terms simply of the number of marks awarded on a well understood system, nor do I see any reason why an employer, making his selection among many candidates, should not hereafter, at some not distant time, be influenced in favor of that candidate who possessed a certificate of having been awarded high marks. Man is a machine of flesh and bone, and a good machine of any kind is worth more than a bad machine."

CHAPTER X.

GRAPHIC ANTHROPOMETRY.

Within the last six years various devices for applying the principles of graphic mathematics to the measures and tests of men have been invented. These have been the outgrowth of the graphic method of Quetelet for showing the mean of any part, as chest girth or height, and the tables of averages and means published from time to time during the last twenty-five years by Dr. Hitchcock of Amherst and the tables of percentages published by Francis Galton and other students of anthropology.

The oldest record of anthropometrical data in any college in the country is to be found at Amherst, where from 1861–2 to this date the students have had the advantage of a physical examination, and advice regarding exercise and a record of their general size has been secured. In 1881 Dr. D. A. Sargent proposed a more extensive list of items for measurement after the plan of Dr. W. T. Brigham of Boston and the European studies in anthropometry. In the following year this plan was adopted at Amherst, and in 1883 at Yale.

The order of items as originally arranged by Dr. Sargent has been rearranged in a better order for graphic representation if not a more logical order by the author in his anthropometric table and the recent record books of Yale. This list of items with only slight modifications is now in general use in all educational institutions where there is an aim at complete methods and the highest results.

The items given on Dr. Hitchcock's table page 126 are extended in the record book of Yale by the addition of age, breadth of chest, development, condition, exercise, vision, hearing, color of hair and eyes, pulse rate, and use of tobacco. The horizontal length is omitted. It may be said in further explanation of these tables of Dr. Hitchcock that

the record of each student is transcribed for him on a table that is compiled from the measurements of men of the same height as the subject—the table here shown being the one that would be given to the man of average height or 1725^{mm}.

In 1878 Dr. D. A. Sargent of Harvard began a systematic record of measurements of students examined by himself, and with the enthusiasm which he excited in the educational world by his abundant preparation for the work, his natural ability and his unequaled field for observation, he soon established a school for training teachers in the theory and practice of gymnastics, and sent out many able instructors imbued with his ideas and ready to assist him in the development of a plan for the determination of some physical standard for American college students that should be derived from a tabulation of all the measurements that could be secured. The work was very comprehensive in scope and the main results have not yet been given to the public, but a partial result has been seen in the graphic chart that was prepared in 1886 (see appendix I.) by which Dr. Sargent was able to give a person an idea of how he compared with the whole body of students whose measures had been tabulated. A second result was seen in the July and October numbers of "Scribner's Magazine" for 1887, where, in an article on "The Physical Characteristics of the Athlete," certain well-known men were pictured graphically as well as literally, and thus the application of the method was more clearly impressed by Dr. Sargent on the minds of persons engaged in physical education.

Meanwhile Dr. Hitchcock of Amherst College, who had published tables of average measurements of Amherst students of all ages, from fifteen up to twenty-eight years, and tables of averages where height instead of age was the basis of tabulation, issued a table in which the latter averages were arranged on a sheet in order from shortest to tallest, by gradation of one centimeter, and the records of an ordinary person, could be indicated on this new table in a graphic way. In 1887 an "adjusted averages" table was

prepared as a simple acknowledgment that the tables were compiled from so few records in many cases that there was considerable irregularity, and therefore after determining the apparent law of variation, the table was made to conform more or less closely to this law, and a better sheet for graphic illustration was produced. The numerical comparison method that has been in use at Amherst for over twenty-five years is still the favorite one there. See page 126. The tables compiled by Dr. Hitchcock are the most complete in existence in this country, the records all having been taken by one man.

In 1888 the measurements of Yale students for five years, that had been taken by the author and that included every man in the undergraduate departments for three years and of two other academical classes, except three men, for four years; altogether over 2,200 men were compiled and arranged in tabular form according to the method of Mr. Galton. See appendix II.

This has furnished a table for graphic illustration and personal information that is fairly complete. It combines the comparison of a man's record with the whole mass of students; a comparison with the *mean*; the statement of the actual numerical size of each part of an individual, and its relation to every other part.

Dr. Fremont Swain of Brooklyn also, in 1888, devised a chart for graphic illustration, using the figures of Dr. Sargent as a basis.

In 1889 Dr. W. L. Savage of Savage's Gymnastic Institute, 308 West 59th Street, New York City, devised a chart for use in plotting the measures of boys and youths. See appendix III. The scheme is very ingenious and will be found generally useful when the table on which it is based is placed in the hands of instructors. The chart can be used for any age and gives absolute record of averages rather than comparative. For boys the method of averages is probably the best, as the method of means can not be scientifically used in compiling data derived from all ages as is being done at present by some prominent teachers and anthropometrists, the material not being homogeneous.

In the present year undoubtedly the most completely graphic method that has yet been devised was completed by Dr. E. Hitchcock, Jr., of Cornell University. See appendix IV. It is based on the tabulation of 15,000 sets of measurements—all made by physicians who are experienced in the work. The figure is drawn from the average of the various measures, and lines to right and left show in a perfect manner the relation of girths as they are actually found to exist. The relation in size of limb girths to semi-girths of the trunk have never been so clearly demonstrated before, and therefore the chart is an important contribution to artistic anatomy. This chart has been the product of a larger compilation of measurements than has ever before been made of the same class in the community.

"The Table first following, which is called the Average Anthropometric Table, exhibits, under fifty-five items, the average measurements of bodily proportions and tests of strength which were obtained during the college years 1861–2 to 1888–9 from the study of nearly eight thousand Amherst College students seventeen to twenty-six years of age.

The Table is so arranged that it may be used to record the measurements of any young man, affording him a ready comparison of himself with the normal or average young man as represented by the printed columns of figures.

To record the results of an examination: if the item is less than the standard as represented in these central columns, put it in the left blank space; if the same or greater, put it in the right. In this way, when the examination is fully recorded, the person can ascertain at a glance, by simple addition or subtraction, how much he varies from the measurements of a young man of 1725 millimetres, or 67.9 inches stature, which is regarded as the standard for the students of Amherst College. Should he desire to know the percentage of difference between himself and the standard, a simple division will inform him, and its result, whether less or greater, can be recorded on the outer blank space."

AVERAGE ANTHROPOMETRIC TABLE.

1725 millimeters, or 67.9 inches being the standard.

	Items.	Per Cent.	Below Average.	Metric System.	English System.	At or above Average.	Per Cent.
	WEIGHT,			Kilos. 61.2	Pounds. 134.6		
	STATURE,			M. M. 1725	Inches. 67.9		
Heights	Sternum,			1410	55.5		
	Navel,			1030	40.6		
	Pubes,			860	33.9		
	Sitting,			903	35.5		
	Knee,			476	18.7		
Girths.	Head,			572	22.5		
	Neck,			349	13.8		
	Chest, repose,			880	34.6		
	Chest, full,			927	36.5		
	Belly,			724	28.4		
	Hips,			893	35.1		
	Right Thigh,			517	20.3		
	Left Thigh,			512	20.2		
	Right Knee,			361	14.3		
	Left Knee,			359	14.2		
	Right Calf,			359	14.2		
	Left Calf,			349	13.8		
	Right Instep,			245	9.5		
	Left Instep,			242	9.4		
	R. U. Arm,			257	10.0		
	L. U. Arm,			253	9.9		
	R. U. A., cont.,			295	11.6		
	Right Elbow,			251	9.8		
	Left Elbow,			247	9.7		
	Right Forearm,			267	10.5		
	Left Forearm,			261	10.2		
	Right Wrist,			166	6.5		
	Left Wrist,			165	6.5		
Breadths.	Head,			155	6.1		
	Neck,			108	4.2		
	Shoulders,			430	16.9		
	Nipples,			198	7.8		
	Waist,			250	9.8		
	Hips,			323	12.7		
*	Chest,						
*	Abdomen,						
Lengths.	R. Shoulder Elbow,			373	14.7		
	Left Shoulder Elbow,			371	14.6		
	Right Elbow Tip,			461	18.1		
	Left Elbow Tip,			459	18.0		
	Right Foot,			260	10.2		
	Left Foot,			259	10.2		
	Stretch of Arms,			1780	70.1		
	Horizontal Length,			1732	68.1		
Strengths.	Lungs,			Kilos. 1.5	Pounds. 3.30		
	Back,			137	301		
	Legs,			166	365		
	Right Forearm,			41.5	91.3		
	Left Forearm,			38.1	83.8		
	Dip,			No. of times. 6			
	Pull Up,			9			
	LUNG CAPACITY,			Litres. 3.77	Cub. In. 230		
	PILOSITY,			Tenths of Body. 2.25			

* ***Depths.***

The numerical method of comparison has been the one in most general use because the data necessary for making a graphic picture of a person's anatomical proportions has only recently been made public. The advantage of a graphic illustration of physical proportions is as great as the advantage of that method in any department of scientific work. It discloses at a glance what is discovered only after considerable time spent in study of figures. It would seem that the union of the graphic and numerical methods of stating the proportions of an individual must be more comprehensive than either method alone, and more satisfactory to both instructor and student.

The use of photography is a legitimate application of graphic principles and it will soon be employed in all gymnasiums where scientific study and accurate work is accomplished. It gives an idea of the form of a man that cannot be derived from figures or graphic lines, and will therefore show results of exercise that figures can not express.

APPENDIX I.

ABLE.

n and compiled by JAY W. SEAVER, M. D.

pounds.)

							BREADTH.							DEPTH.					
	R. Knee.	L. Knee.	R. Calf.	L. Calf.	R. Instep.	L. Instep.	Head.	Neck.	Shoulders.	Chest.	Nipples.	Waist.	Hips.	Chest.	Abdomen.	Capacity of Lungs.	Strength of Back.	Strength of Legs.	Strength of Forearm.
	404	403	406	407	260	260	166	121	457	330	232	300	363	225	225	5.70	229	272	82
	15.9	15.9	16.	16.	10.3	10.3	6.5	4.8	18.	13.	9.2	11.8	14.3	8.9	8.9	348	505	600	150
2	394	394	395	397	256	256	164	119	448	322	225	287	355	215	214	5.40	220	261	75
	15.5	15.5	15.6	15.6	10.1	10.1	6.5	4.7	17.7	12.7	8.9	11.3	14.	8.5	8.4	330	485	575	130
	385	385	386	388	252	252	162	115	442	314	220	281	349	205	204	5.16	211	247	70
	15.2	15.2	15.2	15.3	10.	10.	6.4	4.5	17.4	12.4	8.7	11.1	13.8	8.1	8.	315	465	545	120
1	379	379	377	377	247	248	161	113	433	306	216	274	344	199	201	4.94	195	231	67
	14.9	14.9	14.8	14.8	9.7	9.7	6.3	4.4	17.	12.1	8.5	10.8	13.6	7.8	7.9	302	430	510	115
1	373	373	372	372	243	244	160	112	428	298	212	270	340	197	198	4.76	186	226	65
	14.7	14.7	14.7	14.7	9.6	9.6	6.3	4.4	16.9	11.8	8.3	10.6	13.4	7.8	7.8	290	410	498	110
2	368	370	368	368	241	242	159	111	424	293	208	267	337	195	194	4.63	179	217	63
	14.5	14.6	14.5	14.5	9.5	9.5	6.2	4.4	16.7	11.5	8.2	10.5	13.3	7.7	7.7	282	395	478	106
2	365	367	364	364	239	240	158	111	421	288	205	264	334	193	191	4.53	175	211	61
	14.4	14.5	14.3	14.3	9.4	9.5	6.2	4.4	16.6	11.3	8.1	10.4	13.2	7.6	7.5	273	385	465	102
3	363	365	361	361	238	239	157	110	418	283	203	262	331	191	188	4.45	171	206	60
	14.3	14.4	14.2	14.2	9.4	9.4	6.2	4.3	16.5	11.1	8.	10.3	13.1	7.5	7.4	270	376	454	100
3	360	362	358	358	236	237	156	109	415	279	201	259	329	190	186	4.37	167	201	59
	14.2	14.3	14.1	14.1	9.3	9.3	6.1	4.3	16.4	11.	7.9	10.2	13.	7.5	7.3	264	367	442	98
4	358	359	355	355	234	235	156	108	413	276	199	257	327	189	184	4.30	162	195	58
	14.1	14.2	14.	14.	9.2	9.2	6.1	4.3	16.3	10.9	7.8	10.1	12.9	7.4	7.3	261	356	430	96
4	356	357	352	352	233	234	155	107	410	273	196	255	325	188	183	4.22	157	191	57
	14.	14.	13.9	13.8	9.2	9.2	6.1	4.2	16.2	10.8	7.7	10.	12.8	7.4	7.2	258	345	420	94
5	354	355	350	350	231	232	155	106	407	270	194	253	323	187	181	4.15	153	186	56
	14.	14.	13.8	13.8	9.1	9.1	6.1	4.2	16.	10.7	7.7	10.	12.7	7.4	7.1	253	338	410	92
	352	353	348	347	230	231	155	105	405	268	192	251	321	186	179	4.07	150	183	55
4	13.9	13.9	13.7	13.7	9.1	9.1	6.1	4.2	16.	10.6	7.6	9.9	12.7	7.3	7.	250	330	403	90
	350	351	345	344	229	230	154	105	402	265	190	249	319	184	178	4.00	145	179	53
4	13.8	13.8	13.6	13.6	9.	9.	6.1	4.2	15.8	10.5	7.5	9.8	12.6	7.3	7.	244	320	395	88
	348	349	342	341	227	228	153	104	400	263	188	247	317	182	177	3.92	140	176	52
3	13.7	13.7	13.5	13.5	9.	9.	6.	4.1	15.8	10.4	7.4	9.7	12.5	7.2	7.	240	308	387	86
	345	346	339	338	226	227	153	103	397	261	186	245	315	180	175	3.82	135	171	51
3	13.6	13.6	13.4	13.3	8.9	9.	6.	4.1	15.7	10.3	7.3	9.7	12.4	7.1	6.9	232	298	376	84
	342	343	335	335	225	226	152	103	394	259	184	243	312	178	174	3.73	130	166	50
2	13.5	13.5	13.2	13.2	8.9	8.9	6.	4.1	15.5	10.2	7.2	9.6	13.3	7.	6.9	228	287	365	82
	339	340	331	331	223	224	151	102	391	257	181	240	310	176	172	3.62	125	159	49
2	13.4	13.4	13.	13.	8 8	8.8	5.9	4.	15.4	10.1	7.1	9.5	12.2	6.9	6.8	220	275	350	80
	336	337	327	327	221	222	150	101	387	254	178	237	307	173	170	3.48	120	151	47
1	13.3	13.3	12.9	12.9	8.7	8.7	5.9	4.	15.3	10.	7.	9.4	12.1	6.8	6.7	212	265	332	75
	333	334	323	323	218	219	149	98	382	247	175	234	302	170	167	3.35	113	144	45
1	13.1	13.2	12.7	12.7	8.6	8.6	5.9	3.9	15.1	9.8	6.9	9.2	11.9	6.7	6.6	205	248	317	70
	326	327	316	316	216	216	147	98	375	240	170	230	297	167	163	3.13	104	136	43
	12.8	12.9	12.5	12.5	8.5	8.5	5.8	3.9	14.8	9.5	6.7	9.1	11.7	6.6	6.5	192	230	300	65
2	320	322	310	310	212	212	145	96	368	233	164	225	292	164	159	2.90	95	125	41
	12.6	12.7	12.2	12.2	8.4	8.4	5.7	3.8	14.5	9.2	6.5	8.9	11.5	6.5	6.3	178	210	275	60
	313	315	304	304	208	208	143	94	361	228	160	220	286	160	152	2.65	84	114	38
	12.3	12.4	12	12.	8.2	8.2	5.6	3.7	14.2	9.	6.3	8.7	11.3	6.3	6.	162	185	250	55

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ANTHROPOMETRIC TABLE.

Arranged according to the percentages indicated at the left, from measurements taken and compiled by JAY W. SEAVER, M. D.

(The black figures represent millimeters and kilograms; the red, inches and pounds.)

PER CENT.	AGE.	WEIGHT.	HEIGHT.						LENGTH.									GIRTH.																BREADTH.						DEPTH.				
			Height.	Sternum.	Navel.	Pubis.	Sitting.	Knee.	R. Should. to Elb.	L. Should. to Elb.	R. Elbow to Tip.	L. Elbow to Tip.	Arm reach	R. Foot.	L. Foot.	Head.	Neck.	Chest nor.	Chest infl.	Waist.	Hips.	Biceps.	R. Arm.	L. Arm.	R. Elbow.	L. Elbow.	R. Forearm	L. Forearm	R. Wrist.	L. Wrist.	R. Thigh.	L. Thigh.	R. Knee.	L. Knee.	R. Calf.	L. Calf.	R. Instep.	L. Instep.	Head.	Neck.	Shoulders.	Chest.	Nipples.	Waist.	Hips.	Chest.	Abdomen.	Capacity of Lungs.	Strength of Back.	Strength of Legs.	Strength of Forearm.
1	27.	86.1	1876	1546	1146	956	986	494	412	410	513	512	1950	280	280	600	397	1005	1060	857	1046	333	315	310	272	268	302	295	183	182	616	614	404	403	406	407	260	260	166	121	457	330	232	300	363	225	225	5.70	229	272	82
		190	73.8	60.8	45.1	37.6	38.8	19.5	16.2	16.1	20.2	20.2	76.7	11.	11.	23.6	15.7	39.5	41.8	33.7	41.2	14.3	12.4	12.2	10.7	10.6	11.7	11.6	7.2	7.2	24.3	24.2	15.9	15.9	16.	16.	10.3	10.3	6.5	4.8	18.	13.	9.2	11.8	14.3	8.9	8.9	348	505	600	150
2.5	25.5	81.1	1849	1524	1125	936	971	486	404	403	505	504	1920	277	276	596	386	970	1025	833	1000	348	298	293	263	258	293	285	180	178	593	586	394	395	397	256	256	164	119	448	322	225	287	355	215	214	5.40	220	261	75
		179	72.7	60.	44.3	36.8	38.3	19.1	15.9	15.9	19.9	19.8	75.6	10.9	10.9	23.5	15.2	38.2	40.4	32.8	39.4	13.7	11.7	11.5	10.4	10.2	11.5	11.2	7.1	7.	23.4	23.1	15.5	15.5	15.6	15.6	10.1	10.1	6.5	4.7	17.7	12.7	8.9	11.3	14.	8.5	8.4	330	485	575	130
5	24.	77.	1827	1506	1110	925	960	477	398	396	497	497	1894	274	273	592	379	951	1005	810	974	337	290	284	255	250	288	280	176	175	577	570	385	386	388	388	252	252	162	115	442	314	220	281	349	205	204	5.16	211	247	70
		170	71.9	59.2	43.7	36.4	37.8	18.8	15.7	15 6	19.6	19.6	74.5	10.8	10.7	23.3	14.9	37.4	39.5	31.9	38.4	13.2	11.4	11.2	10.1	9.8	11.3	11.	6.9	6.9	22.7	22.4	15.2	15.2	15.2	15.3	10.	10.	6.4	4.5	17.4	12.4	8.7	11.1	13.8	8.1	8.	315	465	545	70
10	22.6	74.4	1805	1490	1096	910	952	472	393	390	490	488	1872	270	269	588	372	930	980	790	953	327	282	275	249	245	282	275	173	172	560	554	379	379	377	377	247	248	161	113	433	306	216	274	344	199	201	4.94	195	231	67
		164	71.	58.6	43.1	35.8	37.5	18.6	15.5	15.4	19.3	19 2	73.7	10.6	10.6	23.2	14.6	36.6	38.6	31.1	37.5	12.9	11.1	11.	9.8	9.7	11.1	10.8	6.8	6.8	22.	21.8	14.9	14.9	14.9	14.8	9.7	9.7	6.3	4.4	17.	12.1	8.5	10.8	13.6	7.8	7.9	302	430	510	115
15	21.10	72.1	1790	1476	1084	900	944	467	388	386	483	483	1854	266	266	583	363	915	966	779	943	321	276	270	245	241	278	271	171	170	551	544	373	373	372	372	245	244	160	112	428	298	212	270	340	197	198	4.76	186	226	65
		159	70.4	58.1	42.6	35.4	37.2	18.4	15.3	15.2	19.	19.	73.	10.5	10.5	23.	14.5	36.	38.	30.7	37.1	12.6	10.9	10.7	9.7	9.5	11.	10.7	6.7	6.7	21.7	21.4	14.7	14.7	14.7	14.7	9.6	9.6	6.3	4.4	16.9	11.8	8.3	10.6	13.4	7.8	7.8	290	410	498	110
20	21.4	69.4	1775	1464	1074	891	938	463	384	382	480	479	1840	264	264	580	365	905	955	769	934	315	272	266	242	238	275	268	170	169	544	538	368	370	368	368	241	242	159	111	424	293	208	267	337	195	194	4.63	179	217	63
		153	69.8	57.6	42.2	35.1	36.9	18.2	15.1	15.	18.9	18.9	72.4	10.4	10.4	22.8	14.4	35.6	37.6	30.3	36.8	12.4	10.7	10.5	9.5	9.4	10.9	10.5	6.7	6.7	21.4	21.2	14.5	14.6	14.5	14.5	9.5	9.5	6.2	4.4	16.7	11.5	8.2	10.5	13.3	7.7	7.7	282	395	478	106
25	20.11	68.5	1765	1452	1065	884	932	459	381	378	477	476	1826	262	262	578	362	895	946	761	924	311	268	262	239	235	272	265	169	168	538	532	365	367	364	364	239	240	158	111	421	288	205	264	334	193	191	4.53	175	211	61
		151	69.5	57.1	41.9	34.7	36.7	18.1	15.	14.9	18.8	18.7	71.8	10.3	10.3	22.7	14.3	35.3	37.3	30.	36.4	12.3	10.6	10.3	9.4	9.3	10.7	10.4	6.6	6.6	21.2	21.	14.4	14.5	14.3	14.3	9.4	9.5	6.2	4.4	16.6	11.3	8.1	10.4	13.2	7.6	7.5	273	385	465	100
30	20.7	67.6	1754	1443	1057	877	927	456	378	376	474	473	1814	260	260	575	360	888	938	754	918	308	265	259	237	232	270	263	168	167	534	527	363	365	361	361	238	239	157	110	418	283	203	262	331	191	188	4.45	171	206	60
		149	69	56.7	41.6	34.5	36.5	18.	14.9	14.8	18.7	18.6	71.3	10.3	10.3	22.6	14.2	35.	36.9	29.7	36.1	12.1	10.5	10.2	9.3	9.2	10.6	10.3	6.6	6 5	21.	20.7	14.3	14.4	14.2	14.2	9.4	9.4	6.2	4.3	16.5	11.1	8.	10.3	13.1	7.5	7.4	270	376	454	100
35	20.3	65.8	1746	1435	1051	871	922	453	375	373	471	470	1804	259	259	573	357	881	930	747	912	304	262	256	235	230	268	261	167	166	529	523	360	362	358	358	236	237	156	109	415	279	201	259	329	190	186	4.37	167	201	59
		145	68.7	56.5	41.4	34.3	36.3	17.9	14.8	14.7	18.5	18.5	71.	10.2	10.2	22.5	14 1	34.7	36.6	29.4	35.9	12.	10.4	10.1	9.3	9.1	10 5	10.3	6.5	6.5	20.8	20.6	14.2	14.3	14.1	14.1	9.3	9.3	6 1	4.3	16.4	11.	7.9	10.2	13.	7.5	7.3	264	367	442	58
40	20.	64.9	1737	1427	1045	866	917	450	373	372	468	467	1795	258	257	571	354	875	923	741	905	301	259	253	233	228	265	259	166	165	524	519	358	359	355	355	234	235	156	108	413	276	199	257	327	189	184	4.30	162	195	58
		143	68.4	56.2	41 1	34.1	36.1	17.7	14.7	14.6	18.4	18.4	70.7	10.2	10.1	22.5	14.	34.5	36.3	29.2	35.7	11.9	10.3	10.	9.2	9.	10.5	10.2	6.5	6.5	20.6	20.4	14.1	14.2	14.	14.	9.2	9.2	6.1	4.3	16.3	10.9	7.8	10.1	12.9	7.4	7.3	261	356	430	56
45	19.9	63.5	1730	1420	1039	860	913	448	370	369	464	463	1786	256	255	569	352	868	916	735	900	298	256	250	231	226	263	256	165	164	519	514	356	357	352	352	233	234	155	107	410	273	196	255	325	188	183	4.22	157	191	57
		140	68.1	55.9	40.9	33.8	35.9	17.7	14.6	14.5	18.3	18.2	70.3	10.1	10.1	22.4	13.9	34.1	36.1	29.	35.4	11.7	10.1	9.9	9.1	8 9	10.4	10.1	6.5	6.4	20.4	20.3	14.	14.	13.9	13.8	9.2	9.2	6.1	4.2	16.2	10.8	7.7	10.	12.8	7.4	7 2	258	345	420	04
50	19.7	63.1	1724	1415	1033	855	910	446	368	366	462	461	1778	254	254	568	350	861	910	730	896	295	254	248	229	224	261	254	164	163	515	509	354	355	350	350	231	232	155	106	407	270	194	253	323	187	181	4.15	153	186	56
		139	67.8	55.7	40.6	33.6	35.8	17.6	14.5	14.4	18.2	18.2	70.	10.	10.	22.3	13.8	33.9	35.8	28.7	35.3	11.6	10.	9.8	9.	8.8	10.3	10.	6.4	6.4	20.3	20.	14.	14	13.8	13.8	9.1	9.1	6.1	4.2	16.	10.6	7.6	9.9	12.7	7.3	7.	253	338	410	92
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		136	67.5	55.5	40.4	33.5	35.7	17.5	14.4	14.3	18.1	18.1	69.6	9.9	9.9	22.3	13.7	33.6	35.6	28.5	35.	11.5	9.9	9.7	9.	8.7	10.2	9.9	6.4	6.4	20.1	19.8	13.9	13.9	13.7	13.7	9.1	9.1	6.1	4.2	16.	10.6	7.6	9.9	12.7	7.3	7.	250	330	403	90
40	19.4	60.8	1710	1403	1022	844	903	442	364	362	457	456	1759	252	251	565	346	848	898	719	885	288	248	242	225	220	257	250	162	161	507	501	350	351	345	344	229	230	154	105	402	265	190	249	319	184	178	4.00	145	179	53
		134	67.3	55.2	40.2	33.2	35.6	17.4	14.3	14.3	18.	18.	69.2	9.9	9.9	22.2	13.6	33.4	35.3	28.3	34.8	11.4	9.7	9.5	8.9	8.6	10.1	9.8	6.3	6.3	19.9	19.7	13.8	13.8	13.6	13.6	9.	9.	6.1	4.2	15.8	10.5	7.5	9.8	12.6	7.3	7.	244	320	395	88
35	19.1	59.4	1702	1396	1017	840	899	439	361	359	455	454	1749	250	250	561	343	842	892	713	880	285	245	240	222	218	255	248	161	160	503	497	348	349	342	341	227	228	153	104	400	263	188	247	317	182	177	3.92	140	176	52
		131	67.	55.	40.	33.1	35.4	17.3	14.2	14.2	17.9	17.9	68.8	9.9	9.8	22.2	13.5	33.1	35.1	28.1	34.6	11.2	9.7	9.5	8.7	8.6	10.	9.8	6.3	6.3	19.8	19.6	13.7	13.7	13.5	13.4	8.9	8.9	6.	4.1	15.7	10.3	7.3	9.7	12.5	7.2	7.	240	308	387	86
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		129	66.7	54.6	39.7	32.9	35.2	17.2	14.1	14.	17.8	17.8	68.4	9.8	9.8	22.1	13.4	32.9	34.8	27.8	34.4	11.1	9.5	9.4	8.6	8.5	10.	9.7	6.3	6.3	19.6	19.4	13.6	13.4	13.3	8.9	9.	6.	4.1	15.7	10.3	7.3	9.7	12.4	7.1	6.9	232	298	376	84
25	18.6	57.6	1687	1380	1004	829	890	433	357	355	449	447	1729	247	246	560	339	828	877	701	867	278	239	234	218	214	251	244	159	158	492	485	342	343	335	335	225	226	152	103	394	259	184	243	312	178	174	3.73	130	166	50
		127	66.4	54.3	39.5	32.6	35.	17.	14.	14.	17.7	17.6	68.	9.7	9.7	22.	13.3	32.6	34.5	27.6	34.1	11.	9.4	9.2	8.6	8.4	9.9	9.6	6.3	6.2	19.4	19.1	13.5	13.5	13.2	13.2	8.9	8.9	6.	4.1	15.5	10.2	7.2	9.6	12.3	7.	6.9	228	287	365	82
20	18.3	57.	1676	1371	997	823	884	430	354	352	446	444	1715	246	244	558	337	819	868	695	860	273	236	231	215	211	249	242	158	157	486	480	339	340	331	331	223	224	151	102	391	257	181	240	310	176	172	3.62	125	159	49
		125	65.9	54.	39.2	32.4	34.8	16.9	13.9	13.9	17.6	17.5	67.5	9.7	9.6	21.9	13.3	32.3	34.2	27.4	33.9	10.7	9.3	9.1	8.5	8.3	9.8	9.5	6.2	6.2	19.2	18.9	13.4	13.4	13.	13.	8 8	8.8	5.9	4.	15.4	10.1	7.1	9.5	12.2	6.9	6.8	220	275	350	80
15	18.	55.4	1664	1360	986	815	876	426	350	348	442	442	1700	244	242	555	333	810	858	682	868	268	232	227	212	208	246	239	156	156	480	475	336	337	327	327	221	222	150	101	387	254	178	237	307	173	170	3.48	120	151	47
		122	65.5	53.5	38.8	32.1	34.5	16.8	13.8	13.7	17.4	17.4	66.9	9.6	9.5	21.8	13.1	31.9	33.7	27	33.5	10.6	9.1	9.	8.4	8.2	9.6	9.4	6.1	6.1	18.9	18.7	13.3	13.3	12.9	12.9	8.7	8.7	5.9	4.	15.3	10.	7.	9.4	12 1	6 8	6.7	212	265	332	75
10	17.8	53.5	1645	1345	974	806	868	422	346	344	437	437	1687	240	240	550	329	800	846	677	841	263	227	222	208	204	242	235	155	154	474	466	333	334	323	323	218	219	149	98	382	247	175	234	302	170	167	3.35	113	144	45
		118	64.7	52.9	38.4	31.7	34.2	16.6	13.6	13.6	17.2	17.2	66.3	9.5	9.5	21.6	13.	31.5	33.3	26.7	33.1	10.3	9.	8.8	8.2	8.	9.5	9.3	6.1	6.1	18.7	18.3	13.1	13.2	12.7	12.7	8.6	8.6	5.9	3.9	15.1	9 8	6.9	9.2	11.9	6.7	6.6	205	248	317	70
5	17.3	51.3	1626	1325	958	794	854	418	340	338	431	431	1658	236	235	545	324	784	826	661	828	255	222	217	203	200	237	230	152	151	462	455	326	327	316	316	216	216	147	93	375	240	170	230	297	167	163	3.13	104	136	43
		113	64	52.	37.7	31.2	33.6	16.5	13.5	13.4	17.	17.	65.2	9.3	9.3	21.5	12.8	30.8	32.5	26.	32.6	10.	8.8	8.6	8.	7.8	9.3	9.1	6.	6.	18.2	17.9	12.8	12.9	12.5	12.5	8.5	8.5	5.8	3.6	14.8	9.5	6.7	9.1	11.7	6.6	6.5	192	230	300	65
2.5	17.1	49.4	1605	1314	947	780	842	414	334	333	425	425	1630	232	232	540	318	766	812	644	814	247	217	212	198	195	232	225	150	149	450	444	320	322	310	310	212	212	145	96	368	233	164	225	292	164	159	2.90	95	125	41
		109	63.2	51.7	37.3	30.7	33.1	16.3	13.2	13.2	16.7	16.7	64.1	9.1	9.1	21.3	12.5	30.2	32.	25.4	32.	9.7	8.6	8.4	7.7	7.7	9.1	8.9	5.9	5.9	17.7	17.5	12.6	12.7	12.2	12.2	8.4	8.4	5.7	3.8	14.5	9.2	6.5	8.9	11.5	6.5	6.3	178	210	275	60
1	16.7	45.4	1576	1290	931	765	826	403	328	327	418	418	1600	226	226	535	311	740	787	595	794	240	210	205	194	191	226	220	148	147	437	432	313	315	304	304	208	208	143	94	361	228	160	220	286	160	156	2.65	84	114	38
		100	62.	50 8	36.2	30.1	32.5	15.9	12.9	12.9	16.5	16.5	63.	8.9	8.9	21.	12.2	29.1	31.	24.5	31.3	9.5	8.3	8.1	7.6	7.5	8.9	8.7	5.8	5.7	17.2	17.	12.3	12.4	12	12.	8.2	8.2	5.6	3.7	14.2	9.	6.3	8.7	11.3	6.3	6.	162	185	250	55

PRESS OF TUTTLE, MOREHOUSE & TAYLOR.

Also the measures of Mr. ....., taken ....., 18 , by .....

ANTHROPOMETRIC
CHART FOR BOYS.

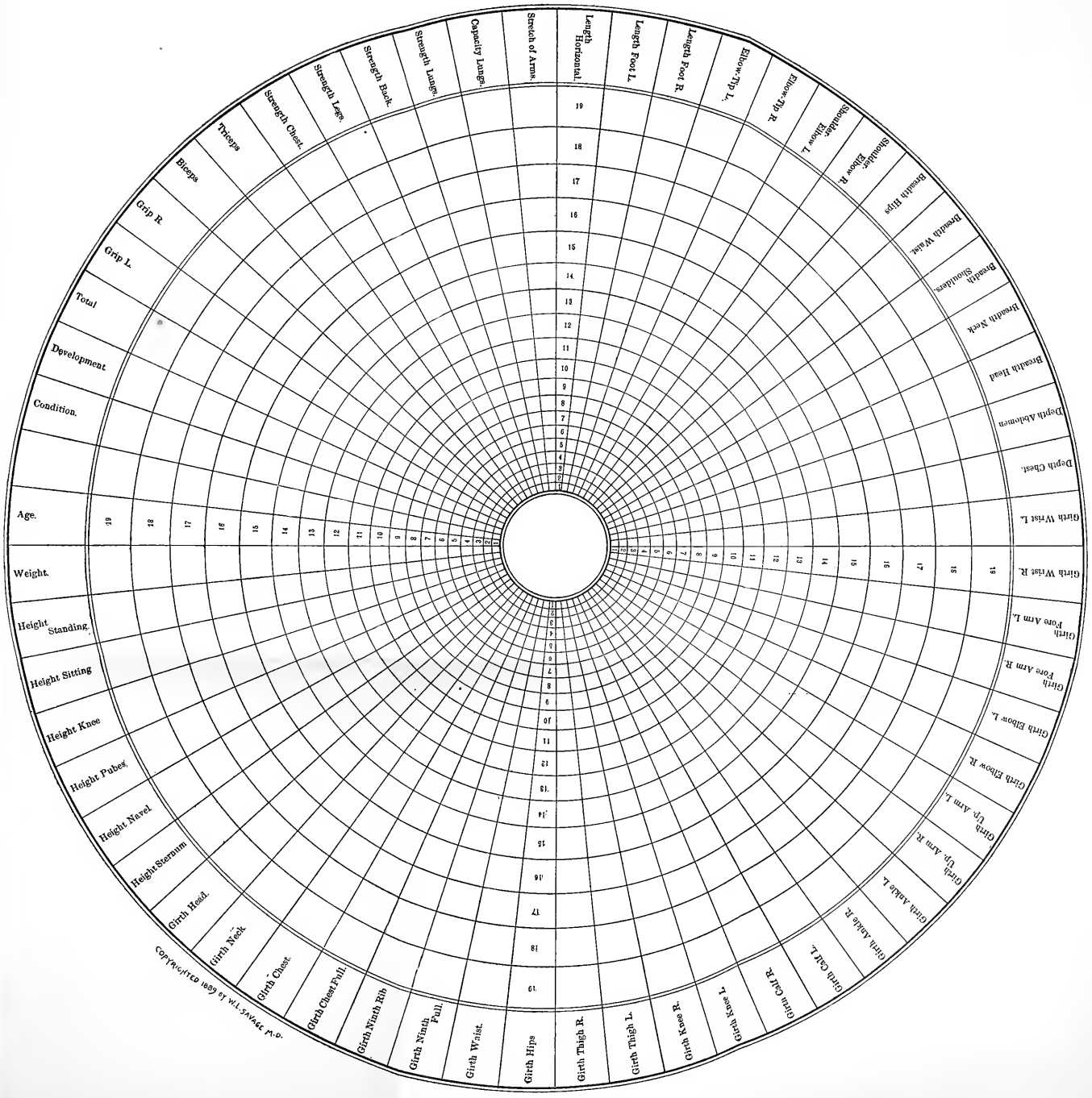
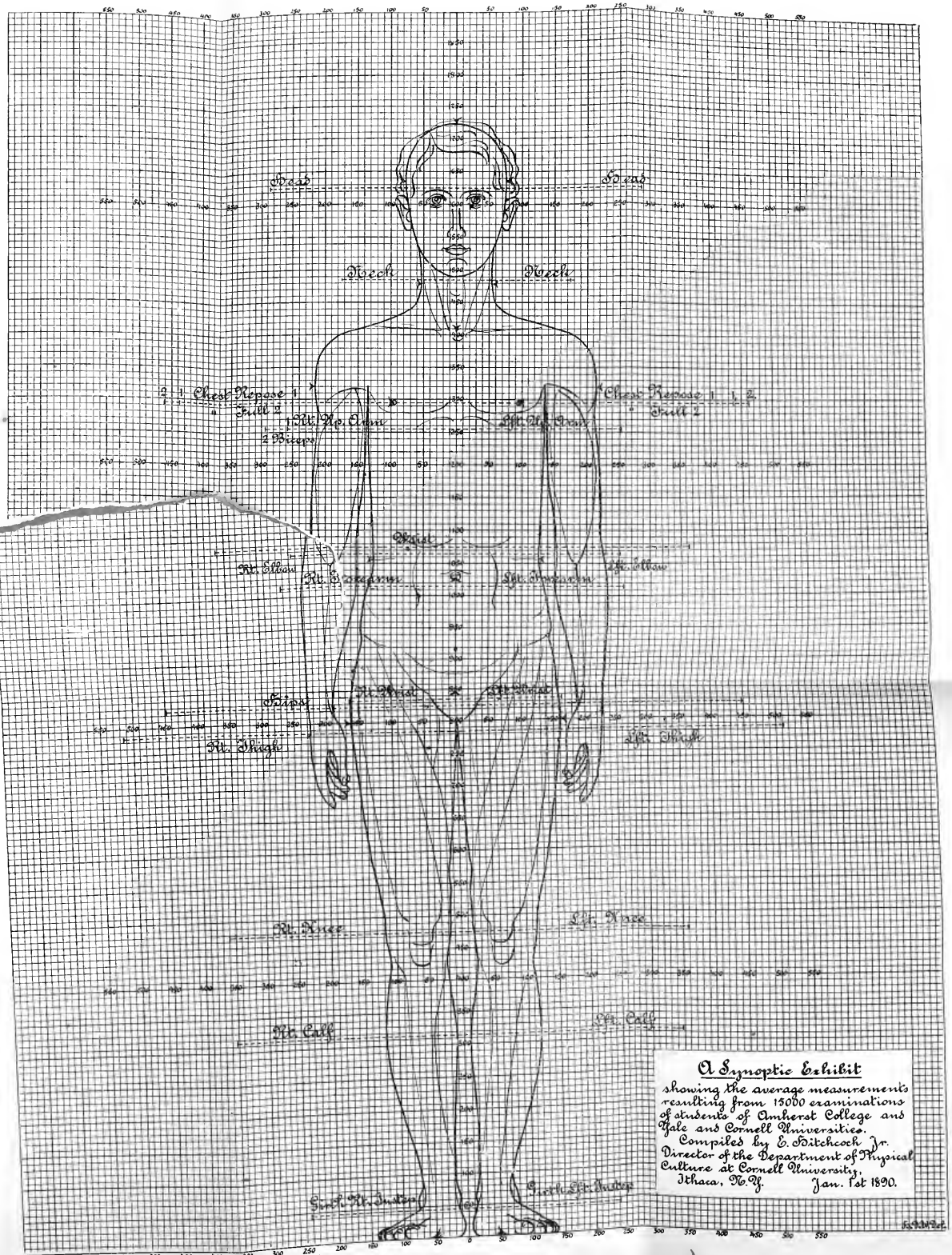


CHART OF _____

EXAMINED _____ 18 ___

BY _____ M.D.



A Synoptic Exhibit

showing the average measurements resulting from 15000 examinations of students of Amherst College and Yale and Cornell Universities.

Compiled by E. Hitchcock Jr.
Director of the Department of Physical Culture at Cornell University,
Ithaca, N.Y. Jan. 1st 1890.